Lloyd's Register

Rules and Regulations for the Classification of Ships, July 2010

Notice No. 6

Effective Date of Latest Amendments:

See page 1

Issue date: February 2011

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RULES AND REGULATIONS FOR THE CLASSIFICATION OF SHIPS, *July 2010*

Notice No. 6

This Notice contains amendments within the following Sections of the *Rules and Regulations for the Classification of Ships, July 2010.* The amendments are effective on the dates shown:

Part	***Chapter***	***Section***	***Effective date***
1	2	2	1 July 2011
3	10	2	1 July 2011
3	13	7, 8	1 July 2011
5	1	3, 7	1 July 2011
5	2	6, 8, 18	1 July 2011
5	3	Cross-references	1 July 2011
5	7	3	1 July 2011
5	9	1, 2, 7, 8	1 July 2011
5	12	1, 2, 9, 10	1 July 2011
5	13	1, 9, 11, 12	1 July 2011
5	14	2, 3, 4, 8, 9, 10	1 July 2011
5	16	1, 2, 3, 4, 5, 6, 7, 8	1 July 2011
5	17	1, 2	1 July 2011
5	19	5	1 July 2011
5	21	1, 2, 3, 4, 5, 6	1 July 2011
6	1	1, 2, 3, 7	1 July 2011
6	2	1, 2, 5, 6, 7, 8, 9, 10, 11, 15, 18, 20	1 July 2011
7	9	2, 3, 4, 5	1 July 2011
7	14	2, 3, 5, 6	1 July 2011
8	2	3	1 July 2011

It will be noted that the amendments also include corrigenda, which are effective from the date of this Notice.

The *Rules and Regulations for the Classification of Ships, July 2010* are to be read in conjunction with this Notice No. 6. The status of the Rules is now:

Rules for Ships	Effective date:	July 2010
Notice No. 1	Effective date:	1 October 2010 & Corrigenda
Notice No. 2	Effective date:	1 January 2011 & Corrigendum
Notice No. 3	Effective date:	1 January 2011 & Corrigenda
Notice No. 4	Effective date:	1 February 2011
Notice No. 5	Effective date:	1 July 2011 & Corrigenda
Notice No. 6	Effective date:	1 July 2011 & Corrigenda

Part 1, Chapter 2
Classification Regulations

Effective date 1 July 2011

■ *Section 2*
Character of classification and class notations

2.4 Class notations (machinery)

(*Part only shown*)

2.4.1 The following class notations are associated with the machinery construction and arrangement, and may be assigned as considered appropriate by the Classification Committee:

✠ LMC	This notation will be assigned when the propelling and essential auxiliary machinery have been constructed, installed and tested under LR's Special Survey and in accordance with LR's Rules and Regulations for the Classification of Ships.
[✠] LMC	This notation will be assigned when the propelling arrangements, steering systems, pressure vessels and the electrical equipment for essential systems have been constructed, installed and tested under LR's Special Survey and are in accordance with LR's Rules and Regulations for the Classification of Ships. Other items of machinery for propulsion and electrical power generation including propulsion gearing arrangements and other auxiliary machinery for essential services that are in compliance with LR Rules and supplied with the manufacturer's certificate will be acceptable under this notation, *see also* Ch 1,3.1.3(b) of the Rules for Materials. The system arrangements of propelling and essential auxiliary machinery are required to be appraised by LR, and found to be acceptable to LR. *See* Section 2.8.2 below.
MCH	This notation will be assigned when the propelling and essential auxiliary machinery has been installed and tested under LR's ~~survey requirements~~ Special Survey and found to be acceptable to LR. Items of machinery and equipment for propelling and auxiliary machinery for essential services supplied with the manufacturer's certificate will be acceptable under this class notation, *see also* Ch 1,3.1.3(c) of the Rules for Materials. The system arrangements of propelling and essential auxiliary machinery are required to be appraised by LR, and found to be acceptable to LR. *See* Section 2.8.3 below.

2.7 Descriptive notes

2.7.3 Where LR's ShipRight procedures for the following have been applied on a voluntary basis, then a descriptive note will, at the Owner's request, be entered in column 6 of the *Register Book*, preceded by the word **ShipRight** (*see also* ShipRight Procedures Overview, Pt 3, Ch 16 and Pt 5, Ch 21):

ES	Enhanced Scantlings
PCWBT(date)	Protection Coatings in Water Ballast Tanks
SEA(Hss-n)	Ship Event Analysis (Hull Surveillance Systems)
SERS	Ship Emergency Response Service
SCM	Screwshaft Condition Monitoring This descriptive note will be assigned where an Owner adopts the requirements for monitoring of the screwshaft. The descriptive note will indicate that equipment and procedures are in place to determine the physical and operational condition of that equipment.
TCM	Main Steam Turbine Condition Monitoring This descriptive note will be assigned where an Owner adopts the requirements for monitoring of the main steam turbine. The descriptive note will indicate that equipment and procedures are in place to determine the physical and operational condition of that equipment.
MCM	Machinery Condition Monitoring This descriptive note will be assigned where an Owner operates an approved Planned Maintenance Scheme as part of the Continuous Survey Machinery (CSM) cycle, and monitoring techniques and equipment are used to record the condition against agreed acceptable limits. The descriptive note will indicate that equipment, procedures and documentation are in place to monitor, control and record the physical and operational condition of the equipment on the ship and control the maintenance routines accordingly. For the design and installation of machinery condition monitoring systems which form part of a machinery planned maintenance scheme approved by LR for the assignment of the descriptive note, the requirements of Pt 5,Ch 21 are applicable.
HPMS	Hull Planned Maintenance Scheme
MPMS	Machinery Planned Maintenance Scheme This descriptive note will be assigned where an Owner operates an approved Machinery Planned Maintenance Scheme as part of the Continuous Survey Machinery (CSM) cycle. The descriptive note will indicate that procedures and documentation are in place to control and record the inspection and maintenance routines of all machinery and equipment in the ship.

RCM	Reliability Centred Maintenance This descriptive note will be assigned where an Owner operates an approved Planned Maintenance Scheme based on the use of Reliability Centred Maintenance as part of the Continuous Survey Machinery (CSM) cycle. The descriptive note will indicate that procedures and documentation are in place to control and record the inspection and maintenance routines of all machinery and equipment in the ship, and that they are based on acceptable and applicable methodology.
BWMP	Ballast Water Management Plan

Part 3, Chapter 10

Welding and Structural Details

Effective date 1 July 2011

■ *Section 2*
Welding

2.9 Inspection of welds

2.9.2 All finished welds are to be subjected to non-destructive examination by personnel designated by the Builder in accordance with the requirements specified in Ch 13,2.12 of the Rules for Materials.

2.9.3 In addition to the requirements of 2.9.2, a number of checkpoints are to be examined by volumetric examination as detailed in 2.9.4 to 2.9.9.

~~2.9.3~~ 2.9.4 Typical locations ~~for volumetric examination~~ and number of checkpoints to be taken are shown in Table 10.2.6. Critical locations as identified by *ShipRight FDA Procedure* (*see* Chapter 16) ~~will~~ are also to be considered. A ~~list~~ plan of the proposed ~~items to be examined~~ checkpoint locations is to be submitted for approval.

2.9.5 Checkpoints are not to be identified on the ship's structural components prior to the welding taking place. Special treatment is not to be given at these locations except critical locations as identified by *ShipRight FDA Procedure*.

2.9.6 For ultrasonic examination the length of each checkpoint is to be 0,5 m and for radiographic examination the length is to be a minimum of 0,3 m. At weld intersections, examination is to be in both weld directions.

2.9.7 The Builder is to provide the Surveyor with all the NDE reports of the checkpoints. These reports are to be available for the Surveyor to review within a short time after inspection, normally considered to be within 10 working days of the examination being carried out. Where welds are repaired the NDE report is to include details of examination of both the defective weld and of the re-weld.

2.9.8 Where the Surveyor notes that a checkpoint has been repaired without record of the original defect, the shipyard is to carry out additional examinations on additional lengths of weld. These lengths are to be adjacent to and on both sides of the defective checkpoint. These additional examinations are to be carried out in the presence of the Surveyor and reported in accordance with 2.9.7.

2.9.9 Where checkpoints are found to contain continuous or semi-continuous defects, additional lengths of weld adjacent to and on both sides of the defective length are to be subject to further volumetric examination. The NDE reports are to be submitted in accordance with 2.9.7.

Existing paragraph 2.9.4 *has been renumbered* 2.9.10.

Table 10.2.6 ~~Non-destructive examination of welds~~ Checkpoint locations

~~Volumetric non-destructive examinations – Recommended extent of testing, *see* 2.9.3~~

Item	Location	Checkpoints~~, *see* Note 1~~
Intersections of butts and seams of fabrication and section welds	Throughout: (a) hull envelope, shell envelope and deck structure plating: • at highly stressed areas, *see* Note ~~3~~ 1 • remainder (b) longitudinal and transverse bulkheads (c) inner bottom and hopper plating	 all 1 in 2~~, *see* Note 4~~ 1 in 2 1 in 2
SDA/FDA	At critical locations identified by SDA or FDA, *see* Note 2	all
Butt welds in plating	Throughout	1 m in 25 m, *see* Notes ~~5 and 6~~ 3 and 4
Seam welds in plating	Throughout	1 m in 100 m
~~Butts~~ Butt welds in longitudinals	Hull envelope within 0,4*L* amidships Hull envelope outside 0,4*L* amidships	1 in 10 welds, *see* Note ~~7~~ 5 1 in 20 welds
Bilge keel ~~butts~~ butt welds	Within 0,4*L* amidships Remainder	all 1 in 3
Structural items when made with full penetration welding as follows: • connection of stool and bulkhead to lower stool shelf plating • vertical corrugations to an inner bottom • hopper knuckles • sheerstrake to deck stringer • hatchways coaming to deck	Throughout Hatchway ends within 0,4*L* amidships Hatchway ends outside 0,4*L* amidships Remainder	 1 m in 20 m 1 m in 20 m 1 m in 10 m 1 m in 20 m 1 m in 40 m all 1 in 2 1 in 40 m

NOTES
~~1. The length of each checkpoint is to be between 0,3 m and 0,5 m.~~
~~3.~~ 1. Typically those at sheerstrake, deck stringer, keel strake and turn of bilge.
2. SDA signifies the *ShipRight Structural Design Assessment Procedure*, FDA signifies the *ShipRight Fatigue Design Assessment Procedure*.
~~4. The extent of testing in those areas shown by SDA to be lightly stressed in service may be reduced to 1 in 4 with the agreement of the Surveyor.~~
~~5.~~ 3. Checkpoints in butt welds and seam welds are in addition to those at intersections.
~~6.~~ 4. Welds at inserts used to close openings in hull envelope plating are to be checked by non-destructive examination.
~~7.~~ 5. Particular attention is to be given to repair rates in ~~longitudinal butts~~ butt welds in longitudinals. Additional welds are to be tested if defects such as lack of fusion or incomplete penetration are observed in more than 10 per cent of the welds examined.
~~8. Agreed locations are not to be indicated on the blocks prior to the welding taking place, nor is special treatment to be given at these locations.~~

Part 3, Chapter 13

Ship Control Systems

Effective date 1 July 2011

■ *Section 7*
Equipment

7.3 High holding power anchors

7.3.2 Anchor designs for which approval is sought as high holding power anchors are to be tested at sea to show that they have holding powers of at least twice those of approved standard stockless anchors of the same mass.

7.3.3 If approval is sought for a range of sizes, then at least two sizes are to be tested. The smaller of the two anchors is to have a mass not less than one-tenth of that of the larger anchor, and the larger of the two anchors tested is to have a mass not less than one-tenth of that of the largest anchor for which approval is sought.

7.3.4 High holding power anchors are to be of a design that will ensure that the anchors will take effective hold of the sea bed without undue delay and will remain stable, for holding forces up to those required by 7.3.2, irrespective of the angle or position at which they first settle on the sea bed when dropped from a normal type of hawse pipe. In case of doubt, a demonstration of these abilities may be required.

7.3.5 The test should normally be carried out from a tug or other suitable vessel, and the pull measured by dynamometer or derived from recently verified curves of tug rev/min against bollard pull. The tests are to be conducted on no fewer than three different types of bottom, which should normally be soft mud or silt, sand or gravel, and hard clay or similarly compacted material. A scope of 10 is recommended for the anchor cable, but in no case should a scope of less than six be used. The same scope is to be used for the anchor for which approval is sought and the anchor that is being used for comparison purposes.

■ *Section 8*
Windlass design and testing

8.3 Control arrangements

8.3.10 Control systems, whether electric, pneumatic or hydraulic, are to comply with the general requirements of Pt 6, Ch 1,2.

8.5 Protection arrangements

8.5.4 For arrangements of power transmission systems and relief requirements *see* Pt 5, Ch 14,9.1.

Part 5, Chapter 1

General Requirements for the Design and Construction of Machinery

Effective date 1 July 2011

■ *Section 3*
Operating conditions

3.1 Availability for operation

3.1.2 Machinery is to be capable of operating at defined power ratings with a range of fuel grades specified by the engine, boiler or machinery manufacturer and agreed by the Owner/Operator.

3.5 Ambient reference conditions

3.5.1 The rating for classification purposes of main and essential auxiliary machinery intended for installation in sea-going ships to be classed for unrestricted (geographical) service is to be based on a total barometric pressure of 1000 mb, an engine room ambient temperature or suction air temperature of 45°C, a relative humidity of 60 per cent and sea-water temperature or, where applicable, the temperature of the charge air coolant at the inlet of 32°C. The ~~engine~~ equipment manufacturer is not expected to provide simulated ambient reference conditions at a test bed.

■ *Section 7*
Spare gear for machinery installations

7.1 Application

7.1.1 Adequate spare parts for the propelling and essential auxiliary machinery, together with the necessary tools for maintenance and repair, are to be readily available for use.

7.1.2 The spare parts to be supplied and their location is to be the responsibility of the Owner, but they must take into account the design and arrangement of the machinery and the intended service and operation of the ship. Account must also be taken of the recommendations of the manufacturers and any applicable statutory requirement of the country of registration of the ship.

7.2 Guidance for spare parts

7.2.1 For general guidance purposes, spare parts for main and auxiliary machinery installations are shown in the LR’s *Spare Gear Guidance* located on Class Direct Live.

Part 5, Chapter 2
Oil Engines

Effective date 1 July 2011

■ *Section 6*
Crankcase safety fitting

~~NOTE~~
~~For the purpose of this Section, starting air compressors are to be treated as auxiliary engines.~~

■ *Section 8*
~~Starting arrangements and air compressors~~
Air compressors and starting arrangements

8.1 General requirements

8.1.1 The requirements of this Section are applicable to reciprocating air compressors intended for starting main engines and auxiliary engines providing essential services.

~~8.2 Air compressors~~

~~*8.2.1*~~ *8.1.2* Two or more air compressors are to be fitted having a total capacity, together with a topping-up compressor where fitted, capable of charging the air receivers within 1 hour from atmospheric pressure, to the pressure sufficient for the number of starts required by ~~8.3~~ 8.12. At least one of the air compressors is to be independent of the main propulsion unit and the capacity of the main air compressors is to be approximately equally divided between them. The capacity of an emergency compressor which may be installed to satisfy the requirements of ~~8.1~~ 8.11 is to be ignored.

~~*8.2.2*~~ *8.1.3* The compressors are to be so designed that the temperature of the air discharged to the starting air receivers will not substantially exceed 93°C in service. A small fusible plug or an alarm device operating at 121°C is to be provided on each compressor to give warning of excessive air temperature. The emergency air compressor is excepted from these requirements.

~~*8.2.3*~~ *8.1.4* Each compressor is to be fitted with a safety valve so proportioned and adjusted that the accumulation with the outlet valve closed will not exceed 10 per cent of the maximum working pressure. The casings of the cooling water spaces are to be fitted with a safety valve or bursting disc so that ample relief will be provided in the event of the bursting of an air cooler tube. It is recommended that compressors be cooled by fresh water.

8.2 Plans and Particulars

8.2.1 Detailed plans, particulars, dimensional drawings and material specifications for compressor crankshafts are to be submitted in triplicate. Plans and particulars for other parts and calculations where applicable are to be submitted to LR upon request.

8.2.2 Where compressors of a special type or design are proposed, the requirements of Pt 7, Ch 16 are to be applied.

8.3 Materials

8.3.1 The specified minimum tensile strength of castings and forgings for compressor crankshafts are to be within the limits given in 2.1.1 and for grey cast iron to be not less than 300 N/mm^2.

8.3.2 Where it is proposed to use materials outside the ranges specified in 8.3.1, details of the chemical composition, heat treatment and mechanical properties are to be submitted for approval.

8.3.3 Materials for components are to be tested as indicated in 2.2.

8.3.4 For crankshafts with a calculated crank pin diameter equal to or greater than 50 mm, they are to be manufactured and tested in accordance with the requirements of the LR Rules for Materials. For calculated crank pin diameters less than 50 mm, a manufacturers' certificate may be accepted, *see* Ch 1,3.1.3(c) of the LR Rules for Materials.

8.4 Design and Construction

8.4.1 A fully documented fatigue strength analysis is to be submitted indicating a factor of safety of 1,5 at the design loads based on a suitable fatigue strength criterion. Alternatively, the requirements of 8.4.2 to 8.4.6 may be used.

8.4.2 The diameter, d_p, of a compressor crankshaft is to be not less than d, determined by the following formula, when all cranks on the shaft are located between two main bearings only:

$$d = v_c \left(\frac{D^2 p Z}{78{,}5} \left(\frac{S}{16} + \frac{a\,b}{a+b} \right) \right)^{1/3} \text{ mm}$$

where
a = distance between inner edge of one main bearing and the centreline of the crankpin nearest the centre of the span, in mm
b = distance from the centreline of the same crankpin to the inner edge of the adjacent main bearing, in mm
$a+b$ = span between inner edges of main bearings, in mm
d_p = proposed minimum diameter of crankshaft, in mm
p = design pressure, in bar g, as defined in Ch 12,1.3.1
D = diameter of cylinder, in mm
S = length of stroke, in mm

V_c = 1,0 for shafts having one cylinder per crank, or
= 1,05 for 90°
= 1,18 for 60°
= 1,25 for 45°
} between adjacent cylinders on the same crankpin
for the shaft and cylinder arrangements as detailed in Table 2.8.1

$$Z = \frac{560}{\sigma_u + 160} \text{ for steel}$$

$$Z = \frac{700}{\sigma_u + 260 - 0{,}059 d_p} \text{ for spheroidal or nodular graphite cast iron}$$

$$Z = \frac{700}{\sigma_u + 260 - 0{,}069 d_p} \text{ for grey cast iron}$$

σ_u = specified minimum tensile strength of crankshaft material, in N/mm^2.

Table 2.8.1 Angle between cylinders

Number of crankpins	Number of cylinders per crank	Angle between cylinders, in degrees		
1 or 2	2	45	60	90
3	2	45	60	—
4	2	45	60	—
1	3	45	60	90
2	3	45	60	—
3	3	45	—	—
1	4	45	60	—
2	4	45	—	—

8.4.3 Where the shaft is supported additionally by a centre bearing, the diameter is to be evaluated from the half shaft between the inner edges of the centre and outer main bearings. The diameter so found for the half shaft is to be increased by six per cent for the full length shaft diameter.

8.4.4 The dimensions of crankwebs are to be such that Bt^2 is to be not less than given by the following formulae:

$0{,}4d^3$ for the web adjacent to the bearing
$0{,}75d^3$ for intermediate webs

where

B = breadth of web, in mm
d = minimum diameter of crankshaft as required by 8.4.2, in mm
t = axial thickness of web which is to be not less than $0{,}45d$ for the web adjacent to the bearing, or $0{,}60d$ for intermediate webs, in mm.

8.4.5 Fillets at the junction of crankwebs with crankpins or journals are to be machined to a radius not less than $0{,}05d$. Smaller fillets, but of a radius not less than $0{,}025d$, may be used provided the diameter of the crankpin or journal is not less than cd,

where

$c = 1{,}1 - 2\frac{r}{d}$ but to be taken as not less than 1,0
d = minimum diameter of crankshaft as required by 8.4.2, in mm
r = fillet radius, in mm.

8.4.6 Fillets and oil holes are to be rounded to an even contour and smooth finish.

8.4.7 An oil level sight glass or oil level indicator is to be fitted to the crankcase.

8.4.8 The crankcases of compressors are to be designed to withstand a pressure equal to the maximum working pressure of the system.

8.4.9 Compressors with shaft power exceeding 500 kW are to have torsional vibration analysis determined in accordance with Ch 8,2 as applicable.

8.4.10 The cooler dimensions for sea-water cooled stage air coolers are to be based on an inlet temperature of not less than 32°C. Where fresh water cooling is used, the cooling water inlet temperature is not to be greater than 40°C.

8.4.11 The cooler dimensions for air cooled stage air coolers are to be based on an air temperature of not less than 45°C.

8.4.12 The piping to and from the air compressor is to be arranged to prevent condensation from entering the cylinders.

8.5 Testing

8.5.1 Cylinders and liners of air compressors are to be subjected to hydraulic pressure tests at 1,5 times the final pressure of the stage concerned.

8.5.2 The compressed air chambers of the intercoolers and after coolers of air compressors are to be subjected to hydraulic pressure tests at 1,5 times the final pressure of the stage concerned.

8.6 Safety arrangements and monitoring

8.6.1 Air compressors are to be arranged and located so as to minimise the intake of air contaminated by oil or water.

8.6.2 Where one compressor stage comprises several cylinders which can be shut off individually, each cylinder shall be equipped with a safety valve and a pressure gauge.

8.6.3 After the final stage, all air compressors are to be equipped with a water trap and after cooler. The water traps, after coolers and the compressed air spaces between the stages are to be provided with discharge devices at their lowest points.

8.6.4 Each compressor stage shall be fitted with a suitable pressure gauge, the scale of which must indicate the relevant maximum permissible working pressure.

8.7 Crankcase relief valves

8.7.1 In compressors having cylinders not exceeding 200 mm bore or having a crankcase gross volume not exceeding 0,6 m^3, crankcase relief valves may be omitted.

8.7.2 Crankcases are to be provided with lightweight spring-loaded valves or other quick-acting and self-closing devices to relieve the crankcases of pressure in the event of an internal explosion and to prevent any inrush of air thereafter. The valves are to be designed and constructed to open quickly and be fully open at a pressure not greater than 0,2 bar.

8.7.3 The valve lids are to be made of ductile material capable of withstanding the shock of contact with stoppers at the full open position.

8.7.4 Each valve is to be fitted with a flame arrester that permits flow for crankcase pressure relief and prevents the passage of flame following a crankcase explosion.

8.7.5 The valves are to be provided with a copy of the manufacturer's installation and maintenance manual for the size and type of valve being supplied. The manual is to contain the following information:

(a) Description of valve with details of function and design limits.
(b) Copy of type test certification.
(c) Installation instructions.
(d) Maintenance and in-service instructions to include testing and renewal of any sealing arrangements.
(e) Actions required after a crankcase explosion.

8.7.6 A copy of the installation and maintenance manual required by 8.7.3 is to be provided on board the ship.

8.7.7 Plans showing details and arrangements of the crankcase relief valves are to be submitted for approval, *see* 1.1.

8.7.8 The valves are to be provided with suitable markings that include the following information:

(a) Name and address of manufacturer.
(b) Designation and size.
(c) Month/Year of manufacture.
(d) Approved installation orientation.

8.8 Number of crankcase relief valves

8.8.1 In compressors having cylinders exceeding 200 mm but not exceeding 250 mm bore, at least two relief valves are to be fitted; where more than one relief valve is required, the valves are to be located at or near the ends of the crankcase.

8.8.2 In compressors having cylinders exceeding 250 mm but not exceeding 300 mm bore, at least one relief valve is to be fitted in way of each alternate crank throw with a minimum of two valves. For compressors having 3, 5, 7, 9, etc., crank throws, the number of relief valves is not to be less than 2, 3, 4, 5, etc., respectively.

8.8.3 In compressors having cylinders exceeding 300 mm bore, at least one valve is to be fitted in way of each main crank throw.

8.8.4 Additional relief valves are to be fitted for separate spaces on the crankcase, such as gear or chain cases, when the gross volume of such spaces exceeds 0,6 m^3.

8.9 Size of crankcase relief valves

8.9.1 The combined free area of the crankcase relief valves fitted on a compressor is to be not less than 115 cm^2/m^3 based on the volume of the crankcase.

8.9.2 The free area of each relief valve is to be not less than 45 cm^2.

8.9.3 The free area of the relief valve is the minimum flow area at any section through the valve when the valve is fully open.

8.9.4 In determining the volume of the crankcase for the purpose of calculating the combined free area of the crankcase relief valves, the volume of the stationary parts within the crankcase may be deducted from the total internal volume of the crankcase.

8.10 Vent pipes

8.10.1 Where crankcase vent or breather pipes are fitted, they are to be made as small as practicable and/or as long as possible to minimise the inrush of air after an explosion.

~~8.1~~ 8.11 Dead ship condition starting arrangements

Existing paragraphs 8.1.1 *to* 8.1.5 *have been renumbered* 8.11.1 *to* 8.11.5.

~~8.3~~ 8.12 Air receiver capacity

Existing paragraphs 8.3.1 *and* 8.3.2 *have been renumbered* 8.12.1 *and* 8.12.2.

~~8.3.1~~ 8.12.1 Where the main engine is arranged for air starting the total air receiver capacity is to be sufficient to provide without replenishment, not less than 12 consecutive starts of the main engine, alternating between ahead and astern if of the reversible type and not less than ~~six~~ 6 consecutive starts if of the non-reversible type. At least two air receivers of approximately equal capacity are to be provided. For scantlings and fittings of air receivers, see Chapter 11.

~~8.3.2~~ 8.12.2 For multi-engine installations, the number of starts required for each engine ~~will be specially considered.~~ are to be as follows:

(a) Two engines through common reduction gearing:
6 starts per engine for fixed pitch propeller/propellers;
3 starts per engine for controllable pitch propeller/propellers.
(b) Three engines or more through common reduction gearing:
3 starts per engine.

8.3.3 No engine is to have fewer than 3 starts for any arrangement. For electric propulsion arrangements, a minimum of 3 starts per engine with a minimum capacity of 12 starts of the largest start air consumption engine in total are required.

~~8.4~~ 8.13 Electric starting

Existing paragraphs 8.4.1 *to* 8.4.6 *have been renumbered* 8.13.1 *to* 8.13.6.

~~8.5~~ 8.14 Starting of the emergency source of power

Existing paragraphs 8.5.1 *to* 8.5.6 *have been renumbered* 8.14.1 *to* 8.14.6.

■ *Section 18*

Program for trials of diesel engines to assess operational capability

18.2 Shipboard trials

~~8.6~~ 8.15 Engine control, alarm monitoring and safety system power supplies

Existing paragraphs 8.6.1 *to* 8.6.3 *have been renumbered* 8.15.1 *to* 8.15.3.

■ *Cross-references*

The pumping arrangements, including cooling water and lubricating oil systems, are to comply with the requirements of Chapter 14.

For spare gear, *see* ~~Chapter 16~~ Ch 1,7.

Table 2.18.2 Scope of shipboard trials for diesel engines

Single ~~main engines soley~~ engine driving a generator~~s~~ for propulsion only

(*Part only shown*)

Part 5, Chapter 3

Steam Turbines

Effective date 1 July 2011

■ *Cross-references*

The pumping arrangements, including cooling water and lubricating oil systems, are to comply with the requirements of Chapters 13 and 14.

For lists of spare gear to be carried, *see* ~~Chapter 16~~ Ch 1,7.

Part 5, Chapter 7

Propellers

Effective date 1 July 2011

■ *Section 3*

Design

3.1 Minimum blade thickness

(*Part only shown*)
3.1.1 For propellers having a skew angle of ~~less than~~ 25° or less, as defined in 1.1.4, the minimum blade thickness, T, of the propeller blades at 25 per cent radius for solid propellers, 35 per cent radius for controllable pitch propellers, neglecting any increase due to fillets, and at 60 per cent radius, is to be not less than:

(*Part only shown*)
3.1.3 For propellers having skew angles of greater than 25° ~~or greater~~, but less than 50°, the mid-chord thickness, $T_{sk0,6}$, at the 60 per cent radius is to be not less than:

Part 5, Chapter 9

Podded Propulsion Units

Effective date 1 July 2011

■ *Section 1* Scope

1.1 General

1.1.3 The requirements of this Chapter relate to podded propulsion units powered by electric propulsion motors, (and are in addition to the requirements for Electric Propulsion in Pt 6, Ch 2,15 and other relevant Sections). Podded propulsion units with other drive arrangements will be subject to individual consideration.

■ *Section 2* General requirements

2.5 Failure Modes and Effects Analysis (FMEA)

2.5.1 An FMEA is to be carried out where a single podded propulsion unit is the vessel's sole means of propulsion, *see* 2.1.1. The FMEA is to identify components where a single failure could cause loss of all propulsion and/or steering capability and the proposed arrangements for preventing and mitigating the effects of such a failure. The assessment required by Pt 6, Ch 2,15.2.2 may be considered for demonstrating the acceptability of the proposed design for propulsion power purposes.

■ *Section 7* Electrical equipment

7.1 General

7.1.4 Details are to be submitted to demonstrate the suitability of cables and busbars intended to operate at temperatures exceeding 95°C, *see* Pt 6, Ch 2,7.2.2 and 10.4.3.

7.2 Slip rings

7.2.1 Where slip rings are incorporated in the design, the details of the following are to be submitted for consideration:

(a) temperature rise test reports;
(b) maximum permitted temperature ratings and design operating temperatures for materials;
(c) where applicable, arrangements for forced air or liquid cooling;
(d) for data communication link slip rings, evidence to demonstrate compliance with Pt 6, Ch 1,2.11.3;
(e) suitability for use under the conditions of vibration expected to arise in normal operation;
(f) evidence of satisfactory operation under the normal angles of inclination given in Pt 6, Ch 2,1.9;
(g) cable securing arrangements; and
(h) evidence of electromagnetic compatibility of control, alarm and safety systems with power circuits.

7.2.2 Where forced cooling is used on slip rings, an alarm is to be initiated to indicate the failure of the forced cooling and it is to be possible to operate the slip ring at a reduced power level defined by the Manufacturer in the event of failure of the forced cooling.

■ *Section 8* Control engineering systems

8.1 General

8.1.3 Steering control is to be provided for podded drives from the navigating bridge~~, the main machinery control station~~ and locally.

8.2 Monitoring and alarms

8.2.1 The requirements for alarms and monitoring arrangements are to be in accordance with Ch 19,5.3 and Table 9.8.1. These alarms are in addition to the requirements of Pt 6, Ch 2,15.

~~*8.2.8* Means are to be provided to identify the cause of propulsion motor power limitation or automatic reduction.~~

Table 9.8.1 ~~**Specific alarms for pod control systems**~~
Additional alarms and safeguards for podded propulsion units

Item	Alarm	Note
Podded drive azimuth angle	—	Indicator, *see* 8.1.4
Propulsion motors	~~Overload, power failure~~ Power supply failure	To be indicated on the navigating bridge
Propulsion motor power limitation or automatic reduction	Activated	*See also* ~~8.2.8~~ Pt 6, Ch 2,15.4.9
Hydraulic oil system pressure	Low	To be indicated on the navigating bridge
Bearing temperature	High	For grease lubricated bearings
Motor temperature	High	*See* Pt 6, Ch 15,1.3
Lubricating oil supply pressure	Low	If separate forced lubrication for shaft bearings; to be indicated on the navigating bridge
Lubricating oil temperature	High	*See also* Pt 6, Ch 2,15.5.9
Lubricating oil tank level for motor bearings	Low	
Water in lubricating oil for motor bearings	High	Required for single podded propulsion units only
Motor cooling air inlet temperature	High	
Motor cooling air outlet temperature	High	
Motor cooling air flow	Low	
Shaft bearing vibration monitoring	High	*See* 6.3.10. Monitoring is to allow bearing condition to be gauged using trend analysis
Shaft sealing	Failure	*See* 6.3.13
Dry space water pump operation	Abnormal	Alarm set to indicate a frequency or duration exceeding that which would normally be expected
Dry space water level	~~High~~ 1st stage high 2nd stage high	— Propulsion motor is to shut down automatically, *See* Note
Slip ring forced cooling	Failure	*See* 7.2.2

NOTE
The second stage dry space water level high alarm is not needed where the electrical equipment installed within the pod is suitable for operation in flooded spaces, *see* 6.8.1.

Part 5, Chapter 12

Piping Design Requirements

Effective date 1 July 2011

■ *Section 1*
General

1.6 Materials

Table 12.1.2 Maximum conditions for pipes, valves and fittings for which manufacturer's materials test certificate is acceptable

Material	Working temperature °C	*DN* = nominal diameter, mm p_w = working pressure, bar
Carbon and low alloy steel Austenitic stainless steel Spheroidal or nodular cast iron	<300	$DN < 50$ or $p_w \times DN < 2500$
Copper alloy	<200	$DN < 50$ or $p_w \times DN < 1500$

■ *Section 2*
Carbon and low alloy steels

2.2 Wrought steel pipes and bends

2.2.1 The maximum permissible design stress, σ, is to be taken as the lowest of the following values:

$$\sigma = \frac{E_t}{1,6} \qquad \sigma = \frac{R_{20}}{2,7} \qquad \sigma = \frac{S_R}{1,6}$$

where

E_t = specified minimum lower yield or 0,2 per cent proof stress at the design temperature; in the case of stainless steel, the 1,0 per cent proof stress at design temperature is to be used

R_{20} = specified minimum tensile strength at ambient temperature

S_R = average stress to produce rupture in 100 000 hours at the design temperature

Values of the maximum permissible design stress, σ, obtained from the properties of the steels specified in Chapter 6 of the Rules for Materials are shown in Tables 12.2.1 and 12.2.2. For intermediate values of specified minimum strengths and temperatures, values of the permissible design stress may be obtained by interpolation.

■ *Section 9*
Piping for LPG/LNG carriers, gas fuelled ships and classed refrigeration systems

9.4 Materials

9.4.1 Stainless steel pipes, valves and fittings for welded fabrication are to be grades 304L, 316L, 321 or 347 in accordance with Ch 6,5 of the Rules for Materials. For non-welded fabrications the grades 304 and 316 may be accepted.

■ *Section 10*
Austenitic stainless steels

10.1 Pipe thickness

10.1.1 The minimum thickness of austenitic stainless steel pipes is to be determined from the formula given in 2.2.1 and either 2.2.3 or 2.2.4 using a corrosion allowance of 0,8 mm. Values of ~~0,2~~ 1,0 per cent proof stress and tensile strength of the material for use in the formula in 2.2.1 may be obtained from Table 6.5.2 in Chapter 6 of the Rules for Materials.

10.1.2 Where stainless steel is used in lubricating oil, hydraulic oil and refrigeration systems, the corrosion allowance may be reduced to ~~0,3~~ 0 mm. For pipes passing through tanks, an additional corrosion allowance is to be added to take account of external corrosion; the addition will depend on the external medium and the value is to be in accordance with Table 12.2.3. Where the pipes are efficiently protected, the corrosion allowance may be reduced by not more than 50 per cent.

Part 5, Chapter 13

Ship Piping Systems

Effective date 1 July 2011

Section 1

General requirements

1.3 Plans and particulars

(*Part only shown*)

1.3.1 The following plans (in diagrammatic form) and particulars are to be submitted for approval. Additional plans should not be submitted unless the arrangements are of a novel or special character affecting classification:

(s) Arrangements of flammable liquids used for ~~power transmission,~~ control and heating systems.
(t) Arrangements of power transmission systems for services essential for safety or for the operation of the ship at sea.
~~(t)~~ (u) Arrangements of cooling water systems for main and auxiliary services.
~~(u)~~ (v) Oil fuel settling service and other oil fuel tanks not forming part of the ship's structure.
~~(v)~~ (w) Arrangements and dimensions of all steam pipes where the design pressure or temperature exceeds 16,0 bar (16,3 kgf/cm^2) or 300°C, respectively, and the outside diameter exceeds 76,1 mm, with details of flanges, bolts and weld attachments, and particulars of the material of pipes, flanges, bolts and electrodes.
~~(w)~~ (x) Details verifying compliance with the capacity of the oil fuel treatment plant required by Ch 14,3.9.1.
~~(x)~~ (y) Details verifying compliance of demands on low pressure air systems by ~~essential users~~ supplying essential services as required by Ch 14,10.1.3.
~~(y)~~ (z) For water ingress detection arrangements, *see* Section 14, plans and information in accordance with Pt 6, Ch 1,1.2 and, additionally, general arrangement plans showing the spaces provided with water ingress detectors, installed equipment locations and cable routes. Details of National Administration approvals are to be included.

Section 9

Additional requirements relating to fixed pressure water spray fire-extinguishing systems

9.1 Bilge drainage requirements

9.1.1 Where arrangements for cooling ~~underdeck~~ cargo ~~spaces~~, Ro-Ro or special category spaces below the bulkhead or freeboard deck, or fire-fighting by means of fixed spraying nozzles or by flooding of ~~the cargo space~~ these spaces with water are provided, the following provisions are to apply, *see also* IMO guidelines (MSC.1/Circ.1320):

(a) The drainage system is to be sized to remove no less than 125 per cent of the combined capacity of both the water spraying system pumps and the required number of fire hose nozzles.
(b) The drainage system valves are to be operable from outside the protected space at a position in the vicinity of the extinguishing system controls.
(c) Adequately sized bilge wells are to be located at the side shell of the ship at a distance from each other of not more than 40 m in each watertight compartment, the bilge wells should be uniformly distributed fore and aft, *see also* Pt 3, Ch 12, 4.1.4 and Pt 4, Ch 2,11.2. For cargo ships only, if this is not possible, the free surface effect on the ship's stability is to be determined and submitted to the Flag Administration for appraisal.

Section 11

Ballast system

11.2 Integrated cargo and ballast systems

11.2.1 Where ballast and cargo systems share power supplies and/or control engineering systems, the additional requirements of this sub-Section apply.

11.2.2 A failure is not to prevent operation of the ballast system by other means.

11.2.3 Controls to stop the cargo system, including normal controls and emergency stop and safety shut-downs, are not to prevent operation of the ballast system.

Section 12

Air, overflow and sounding pipes

12.7 Air pipe closing appliances

12.7.4 Air pipe automatic closing devices shall be so designed that they will withstand both ambient conditions as indicated in Pt 5, Ch 1,3.5 and 3.6 and designed working conditions, and be suitable for use at inclinations up to and including ±40°.

12.7.5 Air pipe automatic closing devices shall be constructed to allow inspection of the closure and the inside of the casing as well as changing the seals.

12.7.6 Efficient ball or float seating arrangements are to be provided for the closures. Bars, cages or other devices are to be provided to prevent the ball or float from contacting the inner chamber in its normal state, and made in such a way that the ball or float is not damaged when subjected to liquid impact due to a tank being overfilled.

12.7.7 Air pipe automatic closing devices are to be self-draining.

12.7.8 The clear area through an air pipe closing device in the open position shall be at least equal to the area of the inlet.

12.7.9 In the case of air pipe closing devices of the float type, suitable guides are to be provided to ensure unobstructed operation under all working conditions of heel and trim.

12.7.10 The maximum allowable tolerances for wall thickness of floats shall not exceed ±10 per cent of thickness.

12.7.11 The inner and the outer chambers of an automatic air pipe head are to be of a minimum thickness of 6 mm.

12.7.12 Casings of air pipe closing devices are to be of approved metallic materials, adequately protected against corrosion.

12.7.13 For galvanised steel air pipe heads, the zinc coating is to be applied by the hot method and the thickness is to be 70 to 100 microns.

12.7.14 For areas of the head susceptible to erosion (e.g. those parts directly subjected to ballast water impact when the tank is being pressed up, such as the inner chamber area above the air pipe plus an overlap of 10° or more either side) an additional harder coating should be applied. This is to be an aluminium-bearing epoxy, or other equivalent coating, applied over the zinc.

12.7.15 Closures and seats made of non-metallic materials are to be compatible with the media intended to be carried in the tank and to sea-water, and suitable for operating at ambient temperatures between –25°C and 85°C.

Part 5, Chapter 14

Machinery Piping Systems

Effective date 1 July 2011

■ *Section 2*
Oil fuel – General requirements

2.1 Flash point

~~*2.1.6* Tanks containing oil fuel are to be separated from crew, passenger and baggage compartments by either:~~

- ~~a gastight steel division additional to the division which retains the oil, or~~
- ~~a division of all-welded steel construction capable of withstanding a head of water at least 1,5 m greater than the maximum service head.~~

2.11 Tanks and cofferdams

2.11.1 Tanks containing oil fuel are to be separated from passenger, crew and baggage compartments by a gastight and watertight boundary or a cofferdam which is suitably ventilated and drained.

■ *Section 3*
Oil fuel burning arrangements

3.1 Oil burning units

3.1.1 All oil burning equipment is to be capable of operating at defined power/rating levels where specified by the Owner/Operator. Confirmation by the manufacturer of this capability is to be provided to LR including the specified power/rating parameters, and operating and maintenance regimes. *See also* Pt 5, Ch 1,3.1.2.

Existing paragraphs 3.1.1 *to* 3.1.4 *have been renumbered* 3.1.2 *to* 3.1.5.

3.1.6 In all dual oil fuel burning systems for boilers, the manufacturer of the combustion equipment is to ensure that the full system, including control and monitoring systems, is capable of continuous operation in all conditions for each fuel grade.

Existing paragraphs 3.1.5 *to* 3.1.11 *have been renumbered* 3.1.7 *to* 3.1.13.

■ *Section 4*
Oil fuel pumps, pipes, fittings, tanks, etc.

4.3 Relief valves on pumps

4.3.1 All pumps which are capable of developing a pressure exceeding the design pressure of the system are to be provided with relief valves. Each relief valve is to be in ~~close~~ closed circuit, i.e. arranged to discharge back to the suction side of the pump and to effectively limit the pump discharge pressure to the design pressure of the system.

■ *Section 8*
Lubricating oil systems

8.5 Maintenance of bearing lubrication

8.5.2 For details of the requirements relating to the lubrication of bearings of electric generators and motors, *see* Pt 6, Ch 2,1.9 and Section 8.

■ *Section 9*
Hydraulic systems

9.1 General

9.1.1 The requirements of this Section are applicable to flammable oils employed under pressure in power transmission, control, actuating and heating systems, and hydraulic media in systems which are providing essential services.

~~*9.1.1*~~ *9.1.2* The arrangements for storage, distribution and utilisation of hydraulic and ~~other~~ flammable oils employed ~~under pressure in power transmission systems, control and actuating systems and heating systems in locations where means of ignition are present~~ in the systems defined in 9.1.1 are to comply with the provisions of 2.9.1 to 2.9.3, 4.3, 4.5, 4.11 and 4.17 where applicable.

9.2 System arrangements

~~*9.2.3* Over-pressure protection is to be provided on the discharge side of all pumps. Where relief valves are fitted for this purpose they are to be fitted in closed circuit, i.e. arranged to discharge back to the system oil tank.~~

Existing paragraphs 9.2.4 *to* 9.2.8 *have been renumbered* 9.2.3 *to* 9.2.7.

■ *Section 10*
Low pressure compressed air systems

10.1 General

10.1.3 The design of LP compressed air systems is to be capable of providing a continuous flow of air to meet the demands of all essential ~~users~~ services under all ambient conditions. This demand may include the use of intermittently used equipment that is part of the ship's equipment, such as power tools for machinery maintenance, testing equipment and line cleaning. Compressed air systems used for diesel engine or gas turbine starting are to comply with the requirements of Ch 2,8 and Ch 4,6 as applicable.

10.2 Compressors and reducing valves/stations

10.2.3 Where LP air is derived only from the starting air system, at least two means of supplying air to the LP air system are to be provided. Each of the two means of supplying air is to have sufficient capability of supplying the total demand on the LP air system with one of the means out of action. ~~To ensure that LP compressed air users do not cause the starting air compressors to operate the starting air system is to be fitted with an auxiliary compressor which is to be capable of continuous running and which can maintain the stored capacity of starting compressed air in the air receivers as required by Ch 2,8 and Ch 4,6 as applicable, whilst supplying essential LP users.~~

10.2.4 Where the starting air system is fitted with an auxiliary compressor it is to be capable of continuous running and to be capable of maintaining the stored capacity of starting compressed air in the air receivers as required by Ch 2,8 and Ch 4,6 whilst also supplying essential LP services.

10.2.5 Where the starting air system is designed to maintain sufficient compressed air for LP services and engine starting arrangements, an additional auxiliary compressor will not be required.

Part 5, Chapter 16

~~Spare Gear for Machinery Installations~~ Waterjet Systems

Effective date 1 July 2011

■ ~~*Section 1*~~

General

1.1 Application

1.1.1 Adequate spare parts for the propelling and essential auxiliary machinery together with the necessary tools for maintenance and repair shall be readily available for use.

1.1.2 The spare parts to be supplied and their location are to be the responsibility of the Owner but must take into account the design and arrangements of the machinery and the intended service and operation of the ship. Account should also be taken of the recommendations of the manufacturers and any applicable statutory requirement of the ~~country of registration of the ship.~~

~~1.2 Tables of spare parts~~

1.2.1 For general guidance purposes, spare parts for main and auxiliary machinery installations are shown in the following Tables:

Table 16.1.1	Spare parts for main oil engines
Table 16.1.2	Spare parts for auxiliary oil engines
Table 16.1.3	Spare parts for main steam turbines
Table 16.1.4	Spare parts for auxiliary steam turbines
Table 16.1.5	Spare parts for auxiliary air compressors
Table 16.1.6	Spare parts for boilers supplying steam ~~propulsion and for essential services.~~

~~Table 16.1.1~~ **~~Spare parts for main oil engines~~** (~~*see continuation*~~)

Item	Spare parts	Number	
		Ships for unrestricted service	Ships for restricted service
Main bearings	Main bearings or shells for one bearing of each size and type fitted, complete with shims, bolts and nuts	1	–
Main thrust block	Pads for one face of Michell-type thrust block	1 set or	1 set
	Inner and outer race with rollers where roller thrust bearings are fitted	1	1
Cylinder liner	Cylinder liner complete with joint rings and gaskets	1	—
Cylinder cover	Cylinder cover, complete with valves, joint rings and gaskets. For engines without covers, the respective valves for one cylinder unit	1	—
	Cylinder cover studs or bolts, with nuts, as applicable for one cylinder	$^{1}/_{2}$ set	—
Cylinder valves	Exhaust valves, complete with casings, seats, springs and other fittings for one cylinder	2 sets	1 set
	Air inlet valves, complete with casings, seats, springs and other fittings for one cylinder	1 set	1 set
	Starting air valve, complete with casing, seat, springs and other fittings	1	1
	Relief valve, complete	1	1
	Fuel injection valves of each size and type fitted, complete with all fittings, for one engine	1 set, *see* Note 1	$^{1}/_{4}$ set
Connecting rod bearings	Bottom end bearings or shells of each size and type fitted, complete with shims, bolts and nuts, for one cylinder	1 set	—
	Top end bearings or shells of each size and type fitted, complete with shims, bolts and nuts, for one cylinder	1 set	—
Pistons	Crosshead type, piston of each type fitted, complete with piston rod, stuffing box, skirt, rings, studs and nuts	1	—
	Trunk piston type, piston of each type fitted, complete with skirt, rings, studs, nuts, gudgeon pin and connecting rod	1	—
Piston rings	Piston rings, for one cylinder	1 set	—
Piston cooling	Telescopic cooling pipes and fittings or their equivalent, for one cylinder unit	1 set	—

~~**Table 16.1.1 Spare parts for main oil engines** *(conclusion)*~~

Item	Spare parts	Number	
		Ships for unrestricted service	Ships for restricted service
Gear and chain for camshaft drives	Chain drive: separate links with pins and rollers of each size and type fitted	6	—
	Bearing bushes of each type fitted	1 set	—
Cylinder lubricators	Lubricator complete, of the largest size, with its chain drive or gear wheels	1	—
Fuel injection pumps	Fuel pump complete, or, when replacement at sea is practicable, a complete set of working parts for one pump (plunger, sleeve, valves, springs, etc.)	1	—
Fuel injection piping	High pressure fuel pipe of each size and shape fitted, complete with couplings	1	—
Scavenge blowers (including turbo-chargers)	Rotors, rotor shafts, bearings, nozzle rings and gear wheels or equivalent working parts if of other types, *see* Note 2	1 set	—
Scavenging system	Suction and delivery valves for one pump of each type fitted	1 set	—
Reduction and/or reverse gear	Complete bearing bush, of each size fitted in the gearcase assembly	1 set	—
	Roller or ball race, of each size fitted in the gearcase assembly	1 set	—
Main engine-driven air compressors	Piston rings of each size fitted	1 set	—
	Suction and delivery valves complete of each size fitted	1/2 set	
Gaskets and packings	Special gaskets and packings of each size and type fitted for cylinder covers and cylinder liners for one cylinder	1 set	—

NOTES

1. Engines with three or more fuel injection valves per cylinder: two fuel injection valves complete per cylinder and a sufficient number of valve parts, excluding the body, to provide, with those fitted, a full engine set.
2. The spare parts may be omitted where it has been demonstrated at the Enginebuilder's Works, or during sea trials, for an engine of the type concerned, that the engine can be manoeuvred satisfactorily with one blower out of action. The requisite blanking and/or blocking arrangements, applicable for running with one blower out of action as demonstrated, are to be available on board.

~~Table 16.1.2 Spare parts for auxiliary oil engines~~

Item	Spare parts	Number	
		Ships for unrestricted service	Ships for restricted service
Main bearings	Main bearing or shells for one bearing of each size and type fitted, complete with shims, bolts and nuts	1	—
Cylinder valves	Exhaust valves, complete with casings, seats, springs and other fittings for one cylinder	2 sets	—
	Air inlet valves, complete with casings, seats, springs and other fittings for one cylinder	1 set	—
	Starting air valve, complete with casing, seat, springs and other fittings	1	—
	Relief valve, complete	1	—
	Fuel valves of each size and type fitted, complete with all fittings, for one engine	$^{1}/_{2}$ set	—
Connecting rod bearings	Bottom end bearings or shells of each size and type fitted, complete with shims, bolts and nuts, for one cylinder	1 set	—
	Top end bearings or shells of each size and type fitted, complete with shims, bolts and nuts for one cylinder	1 set	—
	Trunk piston type: gudgeon pin with bush for one cylinder	1 set	—
Piston rings	Piston rings, for one cylinder	1 set	—
Piston cooling	Piston cooling fittings, for one cylinder unit	1 set	—
Fuel injection pumps	Fuel pump complete, or, when replacement at sea is practicable, a complete set of working parts for one pump (plunger, sleeve, valve springs, etc.)	1	—
Fuel injection piping	High pressure fuel pipe of each size and shape fitted, complete with couplings	1	—
Gaskets and packings	Special gaskets and packings of each size and type fitted, for cylinder covers and cylinder liners for one cylinder	1 set	—

Table 16.1.3 Spare parts for main steam turbines

Item	Spare parts	Number	
		Ships for unrestricted service	Ships for restricted service
Main bearings	Complete bearing bush, of each size and type fitted, for the rotor, pinion and gear wheel shafts, for one engine	1	—
Turbine thrust	Pads of each size for one face of Michell-type thrust, or rings for turbine adjusting block, of each size for one engine Assorted liners for one block where fitted	1 set	1 set
Main thrust block	Pads for one face of Michell-type thrust block	1 set	1 set
	or		
	Inner and outer race with rollers where roller thrust bearings are fitted	1	1
Turbine shaft sealing rings	Carbon sealing rings, where fitted, with springs, for each size and type of gland, for one engine	1 set	—
Oil filters	Disposable filter elements of each type and size fitted	1 set	—

~~Table 16.1.4 Spare parts for auxiliary steam turbines~~

Item	Spare parts	Number	
		Ships for unrestricted service	Ships for restricted service
Main bearings	Complete bearing bush, of each size and type fitted, for the rotor, pinion and gear wheel shafts, for one engine	1	—
Turbine thrust	Pads of each size for one face of Michell-type thrust, or rings for turbine adjusting block, of each size for one engine Assorted liners for one block where fitted	1 set	1 set
Turbine shaft sealing rings	Carbon sealing rings, where fitted, with springs, for each size and type of gland, for one engine	1 set	—
Oil filters	Disposable filter elements of each type and size fitted	1 set	—

Table 16.1.5 Spare parts for auxiliary air compressors

Item	Spare parts	Number	
		Ships for unrestricted service	Ships for restricted service
Piston rings	Rings, of each size fitted, for one piston	1 set	1 set
Valves	Suction and delivery valves, complete, of each size fitted	$^{1}/_{2}$ set	$^{1}/_{2}$ set

Table 16.1.6 Spare parts for boilers supplying steam propulsion and for essential services

Item	Spare parts	Number	
		Ships for unrestricted service	Ships for restricted service
Tube stoppers or plugs	Tube stoppers or plugs, of each size used, for boiler, superheater and economiser tubes	10	6
Oil fuel burners	Oil fuel burners complete or a complete set of wearing parts for the burners, for one boiler	1 set	1 set
Gauge glasses	Gauge glasses of round type	2 sets per boiler	2 sets per boiler
	Gauge glasses of flat type	1 set for every two boilers	1 set for every two boilers

■ *Section 1*
Scope

1.1 General

1.1.1 For the purposes of these Rules, a waterjet propulsion unit is described as a machine which takes in water, by means of a suitable inlet and conduit and accelerates the mass of water using an impeller and nozzle to form a jet propulsion system. The waterjet system comprises the unit and its associated actuation and control devices. The detail of the prime mover is excluded but not its effect on the waterjet system.

1.1.2 This Chapter defines the requirements for the design and service life of marine waterjet propulsion systems and is to be read in conjunction with the General Requirements for the Design and Construction of Machinery in Chapter 1.

1.1.3 The requirements for a fixed or steerable waterjet propulsion system rated at 500 kW and above, which is integral with the ship's hull structure and forms a means of main propulsion, are detailed in this Chapter. This includes support arrangements, controls and the systems necessary to maintain operation and functionality of the waterjet unit.

1.1.4 These requirements relate to waterjets driven by axial or mixed flow pumps. Where units driven by radial flow pumps or inducers are proposed, details are to be submitted for consideration.

■ *Section 2*
General requirements

2.1 Waterjet arrangement

2.1.1 In general, for a ship to be assigned an unrestricted service notation, a minimum of two waterjet systems are to be provided where these form the sole means of propulsion. For ships where a single waterjet system is the sole means of propulsion or steering, a detailed engineering and safety justification is to be evaluated by LR, *see* 2.3.22. This evaluation process will include a risk assessment analysis using a recognised technique to verify that sufficient levels of redundancy and monitoring are incorporated in the waterjet unit's essential support systems and operating equipment.

2.1.2 Waterjet propulsion units are to be capable of continuous operation between their maximum and minimum output power rating at specified operating conditions, *see* Ch 1,3 and within the operational service profiles defined by 2.3.11 and 2.3.12.

2.1.3 It is the Shipbuilder's responsibility to ensure that all of the installed equipment is suitable for operation in the location and under the environmental conditions defined in Chapter 1. Where anticipated environmental conditions are outside these limits or where additional conditions are to be considered, such as vibration and impulsive accelerations, requirements and details of compliance are to be submitted to LR.

2.2 Plans to be submitted

2.2.1 Plans, in triplicate, and information as detailed below and in 2.3 and 2.4, are to be submitted for consideration.

2.2.2 General arrangement plans showing details of the following:
(a) Shafting assembly indicating bearing positions.
(b) Steering assembly.
(c) Reversing assembly.
(d) Shaft sealing arrangement assembly.
(e) Longitudinal section of the complete waterjet unit.

2.2.3 Detailed and dimensioned plans indicating scantlings, materials of construction and where applicable surface finish of the following:
(a) Arrangement of the system, including the intended method of attachment to the hull and building-in, tunnel geometry, shell openings, method of stiffening, reinforcement, etc.
(b) All torque transmitting components, including the shafting system, impeller and stator if fitted.
(c) Steering components, together with a description and line diagram of the control circuit. This is to include steerable exit waterjet nozzles where fitted.
(d) Components of the retractable buckets where these are used for providing astern thrust.
(e) The bearing or bearings absorbing the thrust and supporting the impeller, together with the method of lubrication.
(f) Details of any shafting support or guide vanes used in the waterjet system.

2.2.4 Schematic plans of the lubrication and hydraulics required for steering/reversing systems, together with pipe material, relief valves and the working pressures required.

2.3 Calculations and information

2.3.1 Strength calculations based on fatigue considerations incorporating the maximum continuous torque rating and the most 'onerous' operating condition, *see* 2.3.12, including any short term high power operation, and including the effects of mean and fluctuating loads, transitory loadings, residual stress allowances, and stress raisers, for the following components:
(a) Impeller, stator and any bolting arrangements supporting propulsion or steering loads.
(b) Shaft supports and coupling arrangements.
(c) Inlet guide vanes, if fitted.
(d) Steering components, including the lugs of steerable nozzles where fitted.
(e) Retractable buckets and associated mechanisms which are used to provide astern thrust. A calculation of the hydrodynamic transient loads is to be made for each design and is to include the full ahead to full astern condition. The calculation procedure used is to be supported, where possible, with full scale or model test data, or satisfactory service experience, to validate the design method.

2.3.2 Calculations supporting the connection method of the impeller to the shaft, including details of the fit, push-up, securing, bolting arrangements, etc. In addition, where lengths of shafts are joined using couplings of the shrunk element type, full particulars of the method of achieving the grip force.

2.3.3 Calculations relating to the design of the shaftline as evidence of compliance with Chapter 6.

2.3.4 Torsional vibration calculations of the complete dynamic system in accordance with the relevant requirements included in Chapter 8.

2.3.5 Shaft lateral vibration calculations where required by Chapter 8.

2.3.6 Calculations of the tunnel strength and supporting structure.

2.3.7 A calculation to determine the stresses within the impeller blade.

2.3.8 A calculation of the blade natural frequency for the impeller blades.

2.3.9 A calculation of the relative blade passing frequency between the rotor and stator blades.

2.3.10 The value of the fluctuating stresses during one revolution of the impeller and from transient loadings.

2.3.11 Details of the power/speed range of operation, indicating the maximum continuous torque rating, together with the associated thrusts; this information may be presented in the form of a characteristic curve for the waterjet.

2.3.12 The waterjet thrust for the assessment of the strength condition being considered is to be as follows:

(a) For ships which are intended to operate predominantly in a free-running condition and at steady service conditions, the waterjet thrust is to correspond to the absorption of the maximum continuous shaft power and corresponding revolutions per minute, giving the maximum torque for which the shaft system is approved.
(b) For ships which are designed for several operating conditions, the maximum thrust associated with these conditions and the absorption of the corresponding power, in addition to the maximum continuous powering condition, are to be used in the calculation.
(c) The justification for the thrust selected is to be submitted for consideration in the approval process and this is to include the ship type and the ship speed at the conditions considered.

2.3.13 A justification that the waterjet system will meet the self-priming criteria, *see* 3.1.6.

2.3.14 Specifications of materials and NDE procedures for components essential for propulsion and steering operation and, in the case of the impeller and stator, the yield strength and the fatigue characteristics of the material intended for their manufacture.

2.3.15 A detailed weld specification where an impeller has welded blades.

2.3.16 Full details of the means of corrosion protection in the case of carbon or carbon manganese steel shafts. Alternatively, where it is proposed to use composite shafts, details of the connections at flanges, materials, resin, lay-up procedures, quality control procedures and documentary evidence of fatigue endurance strength is to be provided.

2.3.17 Dry impeller mass and polar moment of inertia.

2.3.18 The prime mover type and designation.

2.3.19 Details of the control engineering aspects of the system design in accordance with Pt 6, Ch 1.

2.3.20 The tolerance specification, agreed between the manufacturer and the Shipbuilder or Owner, to which the components of the unit are to be manufactured is to be defined, together with a justification.

2.3.21 Details of the waterjet's loading reactions together with the positions of application within the hull and is to include the maximum applied thrust, tunnel pressures, moments and forces imposed on the ship.

2.3.22 The waterjet unit's rated flow and head.

2.3.23 Where an engineering and safety justification report is required, the following supporting information is to be submitted:

- A Failure Mode and Effects Analysis report (FMEA), *see* 2.4.
- Design standards and assumptions.
- Limiting operating parameters.
- A statement and evidence in respect of the anticipated reliability of any non-duplicated components.

2.3.24 Recommended installation, inspection, maintenance and component replacement procedures. This is to include any in-water engineering procedures where recommended by the waterjet manufacturer.

2.3.25 All transient loads which the steering unit is likely to experience from manoeuvring, accelerating, decelerating and the sea conditions.

2.4 Failure Mode and Effects Analysis (FMEA)

2.4.1 An FMEA is to be carried out where a single waterjet system is the ship's sole means of propulsion, *see* 2.2.3. The FMEA is to identify components where a single failure could cause the loss of all propulsion and/or steering capability, and the proposed arrangements for preventing and mitigating the effects of such a failure.

2.4.2 The FMEA is to be carried out using the format presented in Table 22.2.1 in Chapter 22 or an equivalent format that addresses the same reliability issues. Analyses in accordance with IEC 60812 *Analysis for System Reliability – Procedure for Failure Mode and Effects Analysis*, or the IMO Code of Safety for High Speed Craft, 2000, Annex 4 – *Procedures for Failure Mode and Effects Analysis*, would be acceptable.

2.4.3 The FMEA is to be organised in terms of equipment and function. The effects of item failures at a stated level and at higher levels are to be analysed to determine these effects on the system as a whole. Actions for mitigation of the effects of failure are to be determined, *see* 2.4.1.

2.4.4 The FMEA is to:
(a) identify the equipment or sub-system and mode of operation;
(b) identify potential failure modes and their causes;
(c) evaluate the effects on the system of each failure mode;
(d) identify measures for reducing the risks associated with each failure mode;
(e) identify measures for preventing failure; and
(f) identify trials and testing necessary to prove conclusions.

2.4.5 At sub-system level it is acceptable, for the purpose of these Rules, to consider failure of equipment items and their functions. It is not required that the failure of components within that equipment item be analysed, *see* Ch 22,2.1.5.

2.4.6 Where a FMEA is used for consideration of systems that depend on software-based functions for control or co-ordination, the analysis is to investigate failure of the functions rather than a specific analysis of the software code itself.

■ *Section 3*
Design requirements

3.1 General

3.1.1 The arrangement of waterjet units is to be such that the ship can be satisfactorily manoeuvred to a declared performance capability. The operating conditions covered are to include the following:
(a) Maximum continuous shaft power/speed to the impeller in the ahead condition at the declared steering angles and conditions.
(b) Manoeuvring speeds of the impeller shaft and/or reversing mechanism in the ahead and astern direction at the declared steering angles and sea conditions.
(c) The stopping manoeuvre described in Ch 1,5.2.2(b).
(d) Astern running conditions for the ship.

3.1.2 The mean loadings are those loadings induced by the waterjet absorbing the mean torque supplied by the prime mover.

3.1.3 Fluctuating loads are defined as those loads which occur during one revolution of the impeller due to cyclic variations. For example, the spatial flow variations and torsional vibration at nominally steady state operating conditions.

3.1.4 Transient loads are defined as those loadings resulting from acceleration and deceleration of the ship, manoeuvring, seaway conditions and other similar forms of loading. This also includes any significant back-pressure effects developed from the operation of the reversing bucket, if fitted.

3.1.5 To ensure self-priming of the waterjet unit, the shaft centreline of the unit is to be lower than the light draught static waterline of the ship. In cases where this is either impracticable or undesirable, the distance of the impeller shaft centreline above the ship's light draught waterline is to be less than or equal to 10 per cent of the pump inlet diameter.

3.1.6 Provision is to be made to allow for the in-service visual inspection of the complete blade surfaces of both the impeller and stator blades using either a direct visual or borescope inspection technique.

3.2 Shaftline

3.2.1 The diameter of the shaftline components are to comply with Chapter 6. For calculation purposes the shaft carrying the impeller is to be taken as equivalent to a screwshaft.

3.2.2 Where it is proposed to use carbon or carbon manganese steel shafts which may be in contact with seawater, these are to be protected.

3.2.3 The diameter of unprotected screwshafts of corrosion-resistant material is not to be less than that given in Vol 7, Pt 11, Ch 2,4.4.7 of the *Rules and Regulations for the Classification of Special Service Craft*.

3.2.4 The use of composite shafts is permitted, *see* 2.3.16.

3.2.5 Where lengths of shafts are joined using couplings of the shrunk element type, a factor of safety, based upon the mean plus the vibratory and transient torques, against slippage of 2,0 is to be achieved for couplings which are located inboard and 2,5 for couplings which are located outboard.

3.2.6 Where shaftline components are bolted together, a factor of safety of 1,5 is to be achieved for the design of the bolted connection when considered in the context of the mean, fluctuating and transitory loadings.

3.2.7 If a keyed fitting of the impeller to the shaft is contemplated, then the requirements of Ch 6,3.10 are to be satisfied.

3.2.8 Where it is proposed to fit a keyless impeller, the fitting is to comply with the requirements of Ch 7,3.2, as applicable, excluding the requirements for Ice Class. Use of the words 'propeller' and 'screwshaft' are to be taken as meaning 'impeller' and 'impellershaft' respectively.

3.3 Shaft support system and guide vanes

3.3.1 In cases where the shaft requires support from the tunnel walls ahead of the impeller or, alternatively, where guide vanes are required to assist the flow around a bend in the ducting system, the supports or guide vanes are to be suitably aligned to the flow and have suitably rounded leading and trailing edges or be of an aerofoil section.

3.3.2 In general, the fillet radius should be greater than or equal to the maximum thickness of the vane or support at that location. Smaller radii may be considered for which the results of an approved measurement programme or calculation procedure are to be submitted. In all cases, a factor of safety of at least 1,5 is to be demonstrated for the maximum designed operating conditions.

3.3.3 A facility for the inspection of the supports or guide vanes is to be provided which will allow either direct visual or borescope inspection of these components and their transition to other members.

3.4 Impeller

3.4.1 A calculation to determine the stresses within the impeller blades is to be carried out, which takes into account the mean blade loading, fluctuating loadings, transient loads and centrifugal force. The computations may be accomplished by either classical methods or numerical analysis. Designs of waterjet systems which have been based on a combination of computational fluid dynamics and finite element methods will be considered. However, it will be necessary to demonstrate to the satisfaction of LR that the formulation of the methods used has been correlated with previous full scale measurement or other calculation experience.

3.4.2 For the purposes of the calculation required by this sub-Section, the fluctuating stresses during one revolution of the impeller is to be taken as 20 per cent of the maximum mean stress, and the stresses from transient loadings are to be taken as 15 per cent of the hydrodynamic mean stress, unless otherwise specified by the designer.

3.4.3 The fatigue assessment of the impeller blades is to be based on the stress in the root sections, excluding the influence of the blade root fillets. This assessment is to include the following components:

- the maximum stresses derived from the mean loading, including both the hydrodynamic and centrifugal components;
- the amplitude of the fluctuating stresses during one revolution of the impeller;
- the stresses derived from transient loading and an allowance for any residual stresses in the material.

It is permissible to combine the variable components of stress in a linear fatigue damage accumulation assessment procedure. A factor of safety of at least 1,5 against fatigue failure is to be demonstrated for the maximum continuous rating condition or any other more onerous condition, *see* 3.1.1.

3.4.4 In general, the fillet radius is to be greater than the maximum thickness of the impeller blade at that location. Composite radiused fillets or elliptical fillets which provide an improved stress concentration factor are preferred.

3.4.5 Where an impeller has bolted-on blades, consideration is to be given to the distribution of stress in the palms of the blade and in the boss and bolting arrangements.

3.4.6 Where an impeller has welded blades the welds are to be of the full penetration type or of equivalent strength. Where laser welding is to be used, details are to be submitted for consideration.

3.4.7 The blades are to be provided with hydrodynamically faired leading and trailing edges which may be either of simple radius or of a more complex aerofoil edge form. The tip clearance, whilst being kept to a minimum for hydrodynamic purposes, is to be sufficient to allow for any transient vibrational behaviour, axial shaft movement or differential thermal expansion.

3.4.8 A calculation of the blade natural frequency for the impeller blades is to be undertaken. The fundamental natural frequency in water of the blade is to be shown to lie outside any expected excitation frequencies within a speed range of the waterjet unit and up to 10 per cent above the maximum impeller speed.

3.5 Stator

3.5.1 The stator blades, where fitted, are to be designed to be capable of withstanding the combined hydrodynamic mean, fluctuating, transient and mechanical loads, including any loads transmitted via shaft bearings, developed by the unit and reacted through the blades when the impeller is absorbing full power. Consideration is to be given to situations when the vessel is either free running or in a condition specified by 3.1.1 or undergoing stopping, accelerating or decelerating manoeuvres. A factor of safety against mechanical failure by yielding of the blades of 1,5 is to be demonstrated.

3.5.2 In general, the fillet radius is to be greater than the maximum thickness of the blade at that location. Composite radiused fillets or elliptical fillets which provide improved stress concentration factors are preferred.

3.5.3 If the stator ring comprises a segmented assembly, then consideration is also to be given to the distribution of stress in the various adjacent members of the overall assembly.

3.5.4 A calculation of the relative blade passing frequency between the rotor and stator blades is to demonstrate that this does not coincide with the natural frequency of the stator blades over the speed range of the waterjet unit and up to 10 per cent above maximum impeller speed.

3.5.5 The stator blades are to be provided with hydrodynamically faired leading edges which may have either a simple radius or a more complex aerofoil edge form.

3.5.6 Where the stator blading assembly forms part of the nozzle, the requirements of 3.7 are to be considered in association with those for the stator assembly.

3.6 Tunnel and securing arrangements

3.6.1 The tunnel is to be adequately supported, framed and fully integrated into the hull structure. The critical locations and integrity of the supports and framing are to be as specified in the FMEA and agreed by the Shipbuilder and LR.

3.6.2 The tunnel and supporting structure scantlings are to be not less than the Rule requirements for the surrounding structure. The strength of the hull structure in way of tunnel(s) is to be maintained. The structure is to be adequately reinforced and compensated as necessary. All openings are to be suitably reinforced and have radiused corners.

3.6.3 Consideration is to be given to providing the inlet to the tunnel with a suitable guard to prevent the ingress of large objects into the rotodynamic machinery. The dimensions of this guard, if fitted, are to strike a balance between undue efficiency loss due to flow restriction and viscous losses, the size of object allowed to pass and the susceptibility to clog with weed and other flow-restricting matter.

3.6.4 The inlet profile of the tunnel is to be designed so as to provide a smooth uptake of the water over the range of vessel operating trims and avoid significant separation and/or cavitation of the flow which may then pass downstream into the rotating machinery.

3.6.5 Design consideration is to take account of pressures which could develop as a result of a duct blockage as well as in relation to the axial location of rotating parts.

3.6.6 The strength of the tunnel and supporting structure are to be examined by direct calculation procedures.

3.7 Nozzle/steering arrangements

3.7.1 In general, the steering systems and components are to comply with the requirements of Chapter 19.

3.7.2 Nozzles can be either of a fixed or steerable form. The design of the nozzle is to take into account fully the change in pressure distribution along its inner surface together with the other mechanical loads (e.g. stator assembly loads) and transient loads caused by the flow-directing attachments which may be reacted through the body of the nozzle. In this analysis the changes to the pressure distribution caused by transient manoeuvres are to be considered.

3.7.3 In addition to the requirements of Chapter 19, the steering mechanism and bucket are to be capable of maintaining the manoeuvrability of the ship in terms of turning circle, zig-zag and stopping requirements within the limits defined by IMO Resolution MSC.137(76), *Standards for Ship Manoeuvrability*.

3.7.4 Consideration is to be given to all transient loads which the steering unit is likely to experience from manoeuvring, accelerating, decelerating and the sea conditions.

3.7.5 The nozzle/bucket is to be given mechanical protection by the Shipbuilder from other impact damage such as collision.

3.8 Bolts

3.8.1 Detailed consideration and analysis is to be given to essential bolting arrangements in critical locations as specified in the FMEA and where indicated by the manufacturer or Shipbuilder and agreed by LR. These are to include; bolts used in the securing of blades or guide vanes, assembly of the unit in the ship and any conduit components.

■ *Section 4*
Piping systems

4.1 General

4.1.1 The piping systems for a waterjet unit are to comply with the general requirements of Chapter 12.

4.1.2 Lubricating and hydraulic oil systems and standby arrangements are to comply with the requirements of Chapter 14; in addition, steering hydraulic systems are to comply with the applicable requirements of Chapter 19.

■ *Section 5*
Control and monitoring

5.1 General

5.1.1 In addition to this Section, the control engineering systems are to comply with Pt 6, Ch 1.

5.1.2 For waterjets used as the only means of propulsion and steering, a standby or alternative power source for the actuating device that controls the angular position and/or the reversing angle is to be provided. Automatic start of the standby pump supplying hydraulic power for steering and reversing is to be provided.

5.1.3 Means are to be provided at each control station to stop each waterjet.

5.2 Monitoring and alarms

5.2.1 In addition to the requirements of Chapter 19, alarms and monitoring requirements are indicated in 5.2.2 to 5.2.4 and Table 16.5.1.

5.2.2 An indication of the angular position of the nozzle is to be provided at each station from which it is possible to control the direction of thrust from the units.

5.2.3 An indication of both the required and actual reversing bucket position is to be provided at each station from which it is possible to control the reversal of thrust.

5.2.4 All alarms associated with waterjet unit faults are to be indicated individually at the control stations and in accordance with the alarm system specified by Pt 6, Ch 1.

Table 16.5.1 Alarms

Item	Alarm	Note
Hydraulic system pressure	Low	—
Hydraulic oil supply tank level	Low	—
Hydraulic oil temperature	High	Where an oil cooler is fitted
Lubricating oil temperature	High	—
Lubricating oil pressure	Low	In forced lubrication systems
Lubricating oil tank level	Low	Where a tank is provided
Ratio of jet rpm/vessel speed	High	Only if installed power per jet >4 MW
Control system failure	Fault	Includes follow-up failure of steering or reversing system
Control system power supply	Failure	—

■ *Section 6*
Electrical systems

6.1 Installation and distribution arrangements

6.1.1 The electrical installation is to comply with the relevant sections of Pt 6, Ch 2.

6.1.2 Waterjet auxiliaries and controls are to be served by individual circuits. Services that are duplicated are to be separated throughout their length as widely as practicable and without the use of common feeders, transformers, converters, protective devices or control circuits.

■ *Section 7*
Inspection, testing and fitting of waterjets

7.1 General

7.1.1 The finished impeller is to be statically balanced on completion of the manufacturing process and meet the requirements of ISO 1940 or an alternative standard acceptable to LR. In the case where the blade tip speed is greater than 60 m/s, dynamic balancing is required unless otherwise agreed by the manufacturer and LR.

7.1.2 The following tests, markings and inspections are to be carried out in the presence of the Surveyor:

(a) The balancing of the impeller or the blades.
(b) Non-destructive examination of the impeller blades and the principal component parts of the propulsion system; *see* Ch 4,8 for austenitic stainless steels and Ch 8,3 for aluminium alloys of the Rules for Materials.
(c) The quality of the fit of the impeller boss on the shaft taper.
(d) The fitting of the impeller to the shaft and its subsequent functional testing.
(e) The finished surfaces of the impeller boss, conical bores, fillets, cones and blade surfaces are to be shown to conform to the tolerances specified on the impeller drawing.

7.1.3 Bolts and nuts in critical locations, as specified in the FMEA and where indicated by the manufacturer or Shipbuilder and agreed by LR, are to be equipped with adequate securing arrangements to the satisfaction of the LR Surveyor.

7.2 Shop tests and installation of waterjet systems

7.2.1 The completed waterjet unit is to undergo a tightness test in which an internal hydrostatic pressure of 1,5 bar above the maximum working pressure of the unit is to be applied.

7.2.2 In cases where the impeller is fitted to the shaft using an interference fit, the bedding of the impeller with the shaft is to be demonstrated in the shop to the satisfaction of the LR Surveyor. Sufficient time is to be allowed for the temperature of the components to equalise before bedding. A contact marking between the bore of the impeller boss and the shaft surface of better than 80 per cent is to be demonstrated when the contact marking ink is spread thinly on the surface of the shaft. Alternative means for demonstrating the bedding of the impeller will be considered.

7.2.3 Means are to be provided to indicate the relative axial position of the impeller boss on the shaft. Permanent reference marks are to be made on the impeller boss, shaft and any nut to indicate angular and axial positioning of the impeller. Care is to be taken in marking the inboard end of the shaft taper to minimise stress raising effects.

7.2.4 A copy of the fitting curve relative to temperature and means for determining any subsequent movement are to be placed on board.

7.2.5 The impeller running clearances are to be checked following the installation of the unit in the ship.

7.2.6 The thrust bearing clearances in the waterjet system are to be verified against the required design values. This is to be done following the installation of the unit in the ship.

7.2.7 The piping systems are to be adequately flushed in accordance with the manufacturer's recommendations and the final levels of contamination recorded. Similarly, pressure testing of the piping systems is to comply with Chapter 12.

7.3 Sea trial requirement

7.3.1 The following requirements are to be complied with:

- Ch 1,5.2 for sea trials.
- Ch 19,7.2 for steering trials.

In addition, the general design capability specified in 3.1.1 is to be demonstrated to the Surveyor's satisfaction.

7.3.2 The control systems relating to the correct functioning of the waterjet are to be the subject of harbour and then sea trials. Demonstration of the requirements of Pt 6, Ch 1 is required and the design combinations of control functions are to be undertaken during the trials programme.

7.3.3 On sea trials and under free running conditions the relationship between ship speed and impeller rotational speed is to be verified against the waterjet's design basis.

7.3.4 Any trials and testing identified from the FMEA report, *see* 2.4.4, are to be carried out.

■ *Section 8*
Installation, maintenance and replacement

8.1 General

8.1.1 All waterjet system propulsion units are to be provided with a copy of the manufacturer's installation and maintenance manual that is pertinent to the actual equipment. *See* 2.3.24.

8.1.2 The manual required by 8.1.1 is to be placed on board and is to contain the following information:

(a) Description of the waterjet propulsion system with details of function and design operating limits. This is also to include details of support systems such as lubrication, cooling and condition monitoring arrangements.
(b) Identification of all components together with details of any that have a defined maximum operating life.
(c) Instructions for installation of the system on board ship with details of any required specialised equipment.
(d) Instructions for commissioning at initial installation and following maintenance.
(e) Maintenance and service instructions to include inspection/renewal of bearings and sealing arrangements. This is also to include component fitting procedures, clearance measurements and lubricating oil treatment where applicable.
(f) Actions required in the event of fault/failure conditions being detected.
(g) Precautions to be taken by personnel working during installation and maintenance.

Part 5, Chapter 17

Requirements for Fusion Welding of Pressure Vessels and Piping

Effective date 1 July 2011

■ *Section 1*
General

1.1 Scope

1.1.2 Fusion welded pressure vessels will be accepted only if manufactured by firms equipped and competent to undertake the quality of welding required for the Class of vessel proposed. ~~The~~ For Class 1, 2/1 and 2/2 pressure vessels, the manufacturer’s works are to be approved in accordance with the requirements specified in *Materials and Qualification Procedures for Ships*, Book A Procedure MQPS 0-4.

■ *Section 2*
Manufacture and workmanship of fusion welded pressure vessels

2.3 Tolerances for cylindrical shells

Table 17.2.1 Tolerances for cylindrical shells

Nominal internal diameter of vessel in mm	Difference between maximum and minimum diameters	Maximum departure from designed form
≤ 300	1,0 per cent of internal diameter	1,2 mm
> 300 ≤ 460		1,6 mm
> 460 ≤ 600		2,4 mm
> 600 ≤ 900		3,2 mm
> 900 ≤ ~~1200~~ 1220		4,0 mm
> 1220 ≤ 1520		4,8 mm
> 1520 ≤ 1900		5,6 mm
> 1900 ≤ 2300	19 mm	6,4 mm
> 2300 ≤ 2670		7,2 mm
> 2670 ≤ 3950		8,0 mm
> 3950 ≤ 4650	19 mm	0,2 per cent of internal diameter
> 4650	0,4 per cent of internal diameter	

Part 5, Chapter 19

Steering Gear

Effective date 1 July 2011

■ *Section 5*
Electric power circuits, electric control circuits, monitoring and alarms

5.3 Monitoring and alarms

5.3.3 Steering control systems are to be monitored and an audible and visual alarm is to be initiated on the navigation bridge in the event of:

- failure of the control system, including command and feedback circuits; or
- unacceptable deviation between the rudder order and actual rudder position and/or unacceptable delay in response to changes in the rudder order.

(*Part only shown*)

Table 19.5.1 Alarm requirements

Item	Alarm	Note
Rudder position	—	Indication, *see* 4.1.3
	Failure	*See* 5.3.3
Steering gear power units, power	Failure	—
Steering gear running motors	Overload,	For alarm and running indication locations, *see* 5.1.2 and 5.1.3
	Single phase	
Control system	Failure	*See* 5.3.3
Control system power	Failure	—

Part 5, Chapter 21

~~ShipRight Procedures for Machinery Planned Maintenance and Condition Monitoring,~~ ~~and~~ Requirements for Condition Monitoring Systems

Effective date 1 July 2011

■ ~~*Section 1*~~
General

1.1 Application

1.1.1 This Chapter is applicable to all machinery, and the requirements are to be applied in conjunction with the relevant Chapters of Parts 5 and 6 and the ShipRight procedures.

1.1.2 Details of LR's ShipRight procedures are given in LR's *ShipRight Procedures Overview* and in this Chapter, where related to particular items and notes.

1.1.3 Details of hull ShipRight procedures are to be found in Pt 3, Ch 16.

1.2 Classification notations and descriptive notes

1.2.1 In addition to the machinery class notations defined in Pt 1, Ch 2, ships complying with the requirements of this Chapter will be eligible to be assigned the descriptive notes as defined in Pt 1, Ch 2,2.7 and associated with the ShipRight procedures.

1.3 Plans and particulars

1.3.1 The information and plans required to be submitted are as specified in the relevant Chapters of Parts 5 and 6 applicable to the particular machinery and in this Chapter where related to particular items and notes.

1.3.2 In addition to information required by 1.3.1, the documents listed in the *ShipRight Procedures for Machinery Planned Maintenance and Condition Monitoring* are to be submitted to LR for consideration.

1.3.3 Equipment type approval reports providing evidence of compliance with 7.2.1 and 7.2.2.

1.3.4 Additional information and plans providing evidence of compliance with the requirements of 7.2.3, 7.3.1 and 7.4.3.

■ *Section 2*
Machinery Planned Maintenance Scheme

2.1 Descriptive note MPMS

2.1.1 Where an Owner operates an approved Planned Maintenance Scheme as part of the Continuous Survey ~~Machinery (CSM) cycle, the descriptive note **MPMS** will, at the Owner's request, be entered in column 6 of the *Register*~~ *Book*.

2.1.2 The descriptive note will indicate that procedures and documentation are in place to control and record the inspection and maintenance routines of all machinery and equipment in the ship.

2.1.3 For the requirements and approval procedures, *see* the *ShipRight Procedures for Machinery Planned Maintenance and Condition Monitoring*.

■ *Section 3*
Machinery Condition Monitoring

3.1 Descriptive note MCM

3.1.1 Where an Owner operates an Approved Planned Maintenance Scheme as part of the Continuous Survey Machinery (CSM) cycle, and monitoring techniques and equipment are used to record the condition against agreed acceptable limits, the descriptive note **MCM** will, at the Owner's request, be entered in column 6 of the *Register Book*.

3.1.2 The descriptive note will indicate that equipment, procedures and documentation are in place to monitor, control and record the physical and operational condition of the equipment on the ship and control the maintenance routines accordingly.

3.1.3 For the design and installation of machinery condition monitoring systems which form part of a machinery planned maintenance scheme approved by LR for the assignment of the **MCM** descriptive note, the requirements of Section 7 are applicable.

3.1.4 For the requirements and approval procedures, *see* the *ShipRight Procedures for Machinery Planned Maintenance and Condition Monitoring*.

■ *Section 4*
Turbine Condition Monitoring

4.1 Descriptive note TCM

4.1.1 Where an Owner adopts the requirements for monitoring of the main steam turbine, the descriptive note **TCM** will, at the Owner's request, be entered in column 6 of ~~the *Register Book*.~~

~~*4.1.2* The descriptive note will indicate that equipment and procedures are in place, in order to determine the physical and operational condition of that equipment.~~

~~*4.1.3* For the requirements, *see* the *ShipRight Procedures for Machinery Planned Maintenance and Condition Monitoring*.~~

~~*Section 5*~~

~~Screwshaft Condition Monitoring~~

~~5.1 Descriptive note SCM~~

~~*5.1.1* Where an Owner adopts the requirements for monitoring of the screwshaft, the descriptive note **SCM** will, at the Owner's request, be entered in column 6 of the *Register Book*.~~

~~*5.1.2* The descriptive note will indicate that equipment and procedures are in place, in order to determine the physical and operational condition of that equipment.~~

~~*5.1.3* For the requirements, *see* Pt 1, Ch 3,17.3 and the *ShipRight Procedures for Machinery Planned Maintenance and Condition Monitoring*.~~

~~*Section 6*~~

~~Reliability Centred Maintenance~~

~~6.1 Descriptive note RCM~~

~~*6.1.1* Where an Owner operates an Approved Planned Maintenance Scheme based on the use of Reliability Centred Maintenance as part of the Continuous Survey Machinery (CSM) cycle, the descriptive note **RCM** will, at the Owner's request, be entered in column 6 of the *Register Book*.~~

~~*6.1.2* The descriptive note will indicate that procedures and documentation are in place to control and record the inspection and maintenance routines of all machinery and equipment in the ship, and that they are based on acceptable and applicable methodology.~~

~~*6.1.3* For the requirements and approval procedures, *see* the *ShipRight Procedures for Machinery Planned Maintenance and Condition Monitoring*.~~

Section ~~7~~ 1

Requirements for Condition Monitoring Systems

~~7.1~~ 1.1 Scope

~~7.1.1~~ 1.1.1 The requirements of this Chapter are applicable to condition monitoring systems which:

(a) provide control, alarm or safety functions for essential machinery and equipment (*see* Pt 6, Ch 1,2.1.1) in accordance with manufacturers recommendations; or

(b) provide machinery condition related information as part of a machinery planned maintenance scheme for use as an alternative to machinery and equipment surveys required by the Regulations (*see* Pt 1, Ch 3) in accordance with LR's ShipRight procedures.

~~7.1.2~~ 1.1.2 Condition monitoring systems which deviate from the requirements of this Section but provide an equivalent level of performance may be submitted to LR for consideration.

~~7.1.3~~ 1.1.3 The requirements of this Section are to be applied to condition monitoring systems where the assignment of the **MCM** descriptive note is requested.

1.2 Plans and particulars

1.2.1 The information and plans required to be submitted are as specified in the relevant Chapters of Parts 5 and 6 applicable to the particular machinery and where specified in this Chapter.

1.2.2 In addition to information required by 1.2.1, the documents listed in the *ShipRight Procedures for Machinery Planned Maintenance and Condition Monitoring* are to be submitted to LR for consideration.

1.2.3 Equipment type approval reports providing evidence of compliance with 1.3.1 and 1.3.2 are to be submitted.

1.2.4 Additional information and plans providing evidence of compliance with the requirements of 1.3.3, 1.4.1 and 1.5.3 are to be submitted.

~~7.2~~ 1.3 General requirements for condition monitoring systems

~~7.2.1~~ 1.3.1 Condition monitoring equipment is to be capable of providing the service for which it is intended and is to satisfy the relevant requirements for condition monitoring equipment in LR's Type Approval System, *Product Assessment and Test Specification* (*TACM*).

~~7.2.2~~ 1.3.2 Condition monitoring equipment is to be suitable for the environment in which it is intended to operate and is to satisfy the relevant requirements for environmental testing in LR's Type Approval System, *Test specification No.1*.

~~7.2.3~~ 1.3.3 The installation of condition monitoring equipment in spaces and locations in which flammable mixtures are liable to collect, e.g. areas containing flammable gas or vapour and/or combustible dust, is to be minimised as far as is practicable and is to satisfy the relevant requirements for the use of electrical equipment in flammable atmospheres in Pt 6, Ch 2,13.

~~7.2.4~~ 1.3.4 Where permanently installed condition monitoring systems are used, the cables are to comply with the relevant Sections of Pt 6, Ch 2,10 and the piping systems are to comply with relevant Sections of Chapters 12 and 13.

~~7.2.5~~ 1.3.5 Where the system is based on programmable electronic systems, the requirements of Pt 6, Ch 1,2.10.21 are to be complied with.

~~7.3~~ 1.4 Requirements for systems providing control, alarm and safety functions

~~7.3.1~~ 1.4.1 In addition to the requirements of ~~7.2~~ 1.3, condition monitoring equipment which provides control, alarm or safety functions for essential machinery and equipment is also to satisfy the relevant requirements for control, alarm and safety systems in Pt 6, Ch 1 and the installation of electrical equipment in Pt 6, Ch 2.

~~7.4~~ 1.5 Requirements for systems providing machinery condition related information as part of machinery planned maintenance scheme

~~7.4.1~~ 1.5.1 In addition to the requirements of ~~7.2~~ 1.3, condition monitoring equipment which provides machinery condition related information as part of a machinery planned maintenance scheme for use as an alternative to machinery and equipment surveys required by the Regulations is also to satisfy the relevant requirements of LR's *ShipRight Procedures for Machinery Planned Maintenance and Condition Monitoring*.

~~7.4.2~~ 1.5.2 The condition monitoring equipment is, as far as is practicable, to be located and installed such that it is accessible for maintenance and survey.

~~7.4.3~~ 1.5.3 The condition monitoring equipment is to be installed in accordance with the manufacturer's instructions, *see* the *Product Assessment and Test Specification* (*TACM*) or by an approved technical organisation as defined in the *ShipRight Procedures for Machinery Planned Maintenance and Condition Monitoring*, and to the satisfaction of the LR Surveyor.

Part 6, Chapter 1

Control Engineering Systems

Effective date 1 July 2011

■ *Section 1*
General requirements

1.2 Plans

1.2.3 Plans for the control, alarm and safety systems of the following are to be submitted:

- Air compressors.
- Bilge and ballast systems.
- Cargo pumping systems for tankers.
- Cargo and ballast pumps in hazardous areas.
- Cargo tank, ballast tank and void space instrumentation where such arrangements are specified by other sections of the Rules (e.g. water ingress detection, gas detection).
- Controllable pitch propellers.
- Electric generating plant.
- Fixed water based local application fire-fighting systems, *see* 2.9.
- Incinerators.
- Inert gas generators.
- Main propelling machinery including essential auxiliaries.
- Miscellaneous machinery or equipment (where control, alarm and safety systems are specified by other Sections of the Rules).
- Oil fuel transfer and storage systems.
- Steam raising plant. (Boilers and their ancillary equipment).
- Steering gear.
- Thermal fluid heaters.
- Transverse thrust units.
- Valve position indicating systems.
- Waste-heat boiler.
- Waterjets for propulsion purposes.
- ~~Cargo tank, ballast tank and void space instrumentation where such arrangements are specified by other sections of the Rules (e.g. water ingress detection, gas detection).~~
- Windlasses.

1.2.5 **Programmable electronic systems**. In addition to the documentation required by 1.2.2 the following is to be submitted:

- (a) System requirements specification.
- (b) System integration plan, *see* ~~2.13.2~~ 2.14.2.
- (c) Failure Mode and Effects Analysis (FMEA), *see* ~~2.13.5~~ 2.14.5.
- (d) Details of the hardware configuration in the form of a system block diagram, including input/output schedules.
- (e) Hardware certification details, *see* 2.10.5 and ~~2.12.3~~ 2.13.3.
- (f) Software quality plans, including applicable procedures, *see* 2.10.25.
- (g) Factory acceptance, integration and sea trial test schedules for hardware and software.
- (h) Details of data storage arrangements, *see* 2.10.10 and ~~2.12.6~~ 2.13.6.

1.2.6 For wireless data communication equipment:

- (a) Details of manufacturer's installation and maintenance recommendations;
- (b) network plan with arrangement and type of aerials and identification of location;
- (c) specification of wireless communication system protocols and management functions, *see* 2.12.4; and
- (d) details of radio frequency and power levels, including details of those permitted by the National Administration.

Existing paragraphs 1.2.6 *to* 1.2.9 *have been renumbered* 1.2.7 *to* 1.2.10.

■ *Section 2*
Essential features for control, alarm and safety systems

2.2 Control stations for machinery

2.2.1 A system of alarm displays and controls is to be provided which readily ensures identification of faults in the machinery and satisfactory supervision of related equipment by duty personnel. This may be provided at a main control station or, alternatively at subsidiary control stations. In the latter case, a master alarm display is to be provided at the main control station showing which of the subsidiary control stations is indicating a fault condition.

2.5 Control systems, general requirements

2.5.6 Remote or automatic controls are to be provided with sufficient instrumentation at the relevant control stations to ensure effective control by duty personnel and to indicate that the system is functioning correctly.

2.5.8 Failure of a control system is not to result in the loss of ability to provide essential services by alternative means. This may be achieved by manual control or redundancy within the control system or redundancy in machinery and equipment, *see also* ~~2.12.2~~ 2.13.2. Instrumentation is to be provided at local manual control stations to ensure effective operation of the machinery by duty personnel.

2.10 Programmable electronic systems – General requirements

2.10.16 User interfaces are to ~~be designed in accordance with appropriate ergonomic principles to meet user needs and~~ enable timely access to desired information or control of functions. A system overview is to be readily available.

2.10.20 Display units are to comply with the requirements of ~~International Electrotechnical Commission Standard IEC 60950:1991~~ an acceptable National or International Standard, e.g. IEC 60950:1999, *Safety of information technology equipment,* ~~*including electrical business equipment,*~~ in respect of emission of ionising radiation.

2.10.21 ~~Symbols used in mimic diagrams are to be visually representative and are to be consistent throughout the systems' displays.~~ The symbols used in mimic diagrams for the services listed in Pt 6, Ch 2,1.5.1 are to be consistent across all displays.

2.11 Data communication links

2.11.3 Loss of a data communication link is not to result in the loss of ability to operate any essential service by alternative means, *see also* ~~2.12.2~~ 2.13.2.

2.11.7 System self-monitoring capabilities are to be arranged to initiate transition to a defined safe state for the complete installation in the event of data communication failure, *see also* 2.5.4.

Existing paragraphs 2.11.7 *to* 2.11.10 *have been renumbered* 2.11.8 *to* 2.11.11.

2.12 Additional requirements for wireless data communication links

2.12.1 The requirements of this sub-Section are in addition to 2.11 and apply to systems incorporating wireless data communication links.

2.12.2 Wireless data communication links are not to be used for safety critical systems or essential services that are required for the propulsion or safety of the ship, except as permitted by 2.12.3.

2.12.3 For services not required to operate continuously, wireless data communication links may be considered where an alternative means of operation can be brought into action within an acceptable period of time.

2.12.4 Wireless data communication is to employ recognised international wireless communication system protocols that incorporate the following:

- (a) Message integrity: fault prevention, detection, diagnosis and correction, ensuring that the received message is not corrupted or altered when compared to the transmitted message.
- (b) Configuration and device authentication: is to permit connection only of devices that are included in the system design.
- (c) Message encryption: protection of the confidentiality and/or criticality of the data content.
- (d) Security management: protection of network assets and prevention of unauthorised access to network assets.

2.12.5 The wireless system is to comply with the radio frequency and power level requirements of the International Telecommunications Union and any requirements of the National Administration with which the ship is registered.

2.12.6 Compliance with different port state and local regulations pertaining to the use of radio-frequency transmission that would prohibit the operation of a wireless data communication link, due to frequency and power level restrictions, is not addressed by these requirements and is the responsibility of the Owner and Operator.

Existing sub-Sections 2.12 *and* 2.13 *have been renumbered* 2.13 *and* 2.14.

■ *Section 3*
Control and supervision of unattended machinery

3.2 Oil engines for propulsion purposes

(*Part only shown*)

Table 1.3.1(a) Oil engines for propulsion purposes: Alarms and slowdowns
(*conclusion*)

Item	Alarm	Note
Electrical starting battery charge level*	Low	~~—~~ Electric start engines, *see also* Pt 5, Ch 2,8.4.5

3.2.4 The following engine services are to be fitted with automatic temperature controls so as to maintain steady state conditions throughout the normal operating range of the propulsion engine(s).

(a) Lubricating oil supply.
(b) Oil fuel supply, oil fuel grades requiring heating or cooling only, *see also* 3.2.5.
(c) Piston coolant supply, where applicable.
(d) Cylinder coolant supply, where applicable.
(e) Fuel valve coolant supply, where applicable.

3.2.5 ~~The oil fuel supply may be fitted with an automatic control for viscosity instead of the temperature control required by 3.2.4.~~ Where the oil fuel supply is heated, automatic control for viscosity may be fitted in lieu of the temperature control required by 3.2.4.

3.4 Gas turbine machinery

(*Part only shown*)

Table 1.3.3 Gas turbine machinery: Alarms and safeguards

Item	Alarm	Note
Overspeed	High	Automatic shutdown *see also* Pt 5, Ch 4,8.2
Starting air pressure	Low	—
Electrical starting battery charge level	Low	—
Starting hydraulic pressure	Low	—

3.4.2 The following turbine services are to be fitted with automatic temperature controls so as to maintain steady state conditions throughout the normal operating range of the turbine:

(a) Lubricating oil supply.
(b) Oil fuel supply, oil fuel grades requiring heating or cooling only, *see also* 3.4.3.
(c) Exhaust gas.

3.4.3 ~~The oil fuel supply may be fitted with an automatic control for viscosity instead of the temperature control required by 3.4.2.~~ Where the oil fuel supply is heated, automatic control for viscosity may be fitted in lieu of the temperature control required by 3.2.4.

3.5 Main, auxiliary and other boilers

3.5.2 The following boiler services are to be fitted with automatic controls so as to maintain steady state conditions throughout the normal operating range of the boiler:

(a) Combustion system.
(b) Oil fuel supply temperature or viscosity, ~~heavy oil only~~ oil fuel grades requiring heating or cooling as applicable.
(c) Boiler drum water level.
(d) De-aerator water level, where applicable.
(e) Superheated steam pressure, where applicable.
(f) Superheated steam temperature, where applicable.
(g) De-superheated steam pressure, where applicable.
(h) De-superheated steam temperature, where applicable.

3.9 Auxiliary engines and auxiliary steam turbines

(*Part only shown*)

Table 1.3.8 Auxiliary engines and auxiliary steam turbines: Alarms and safeguards
(*see continuation*)

Item	Alarm	Note
OIL ENGINES		
Electrical starting battery charge level	Low	— Electric start engines, *see also* Pt 5, Ch 2,8.4.5

~~3.14 Waterjets~~

3.14.1 Alarms and safeguards are indicated in 3.14.2 to 3.14.4 and Table 1.3.11.

Table 1.3.11 Waterjets: Alarms and safeguards

Item	Alarm	Note
Hydraulic system pressure	Low	—
Hydraulic oil supply tank level	Low	—
Hydraulic oil temperature	High	Where an oil cooler is fitted
Hydraulic system flow	Low	—
Lubricating oil pressure	Low	—
Control system	Fault	—
Control system power supply	Failure	—

~~*3.14.2* For waterjets used as the only means of propulsion, a standby or alternative power source of actuating medium for controlling the angular position and/or the reversing angle is to be provided. Automatic start of the standby pump supplying hydraulic power for steering and reversing is to be provided.~~

~~*3.14.3* An indication of the angular position of waterjets is to be provided at each station from which it is possible to control the angular position.~~

~~*3.14.4* An indication of the bucket position is to be provided at each station from which it is possible to control the reversal of thrust.~~

~~3.15~~ 3.14 Miscellaneous machinery

Existing paragraphs 3.15.1 *to* 3.15.6 *have been renumbered* 3.14.1 *to* 3.14.6.

Existing Table 1.3.12 *has been renumbered* Table 1.3.11.

■ *Section 7*
Trials

7.1 General

7.1.4 Wireless data communication links are to be operational and tested during trials. Tests are to demonstrate that radio-frequency transmission does not interfere with the operation of equipment required by this Chapter or other Sections of the Rules and does not itself malfunction as a result of electromagnetic interference during expected operating conditions. Reversionary modes are to be activated to demonstrate continued safe and effective operation in the event of fault conditions.

Part 6, Chapter 2
Electrical Engineering

Effective date 1 July 2011

■ *Section 1*
General requirements

1.2 Plans

1.2.7 Simplified circuit diagram of electrical propulsion system (where fitted) giving details of:

(a) ratings of electrical machines, transformers, batteries, dynamic braking assemblies and semiconductor converters;

(b) lubrication and cooling arrangements, where provided;

~~(b)~~ (c) insulation type, size and current loadings of cables;

~~(c)~~ (d) make, type and rating of circuit-breakers and fuses;

~~(d)~~ (e) instrumentation and protective devices;

~~(e)~~ (f) earth fault indication/protection;

~~(f)~~ (g) ~~explanation of the system with details of the~~ propulsion control systems, and the procedures used to ensure that there is satisfactory control of the design in relation to the requirements of ~~Section 15~~ Section 15,4; and

(h) harmonic analysis.

1.2.14 For high voltage rotating machines, type test reports for stator insulation systems, *see* 8.1.10.

Existing paragraphs 1.2.14 *to* 1.2.19 *have been renumbered* 1.2.15 *to* 1.2.20.

1.3 Surveys

1.3.3 For electric propulsion systems, in addition to the equipment listed in 1.3.2, the following equipment is to be surveyed by the Surveyors during manufacture and testing:

- dynamic braking assemblies, *see* 15.5.8;
- exciters;
- filters;
- reactors;
- ~~dynamic braking assemblies;~~
- pre-magnetisation transformers; and
- slip ring assemblies.

~~*1.3.5* For ships having the class notation **OPS**, in addition to the equipment listed in 1.3.2, the following Connection Equipment covered by Pt 7, Ch 14, where applicable, is to be surveyed by the Surveyors during manufacture and testing:~~

- ~~flexible cables, with assembled plug and socket outlets, if any;~~
- ~~busbar trunking;~~
- ~~filters;~~
- ~~converters; and~~
- ~~slip ring assemblies.~~

Existing paragraph 1.3.6 *has been renumbered* 1.3.5.

1.5 Definitions

(*Part only shown*)

1.5.1 Essential services are those necessary for the propulsion and safety of the ship, such as the following:

- lighting systems for those parts of the ship normally accessible to and used by personnel and passengers;
- liquefied gas cargo handling;
- navigational aids where required by Statutory Regulations;
- power sources and supply systems for supplying the above services~~.~~ ; and
- steam raising plant, where steam is required for other essential services.

1.9 Inclination of ship

1.9.2 In ships for the carriage of liquefied gas the emergency source of electrical power is also to remain operable under the conditions described in the *Rules and Regulations for the Construction and Classification of Ships for the Carriage of Liquefied Gases in Bulk* (hereinafter referred to as the Rules for Ships for Liquefied Gases), Chapter 10, LR 10.1-05 General. In ships for the carriage of liquid chemicals the emergency source of electrical power is also to remain operable under the conditions described in the *Rules and Regulations for the Construction and Classification of Ships for the Carriage of Liquid Chemicals in Bulk* (hereinafter referred to as the Rules for Ships for Liquid Chemicals), Chapter 10, LR 10.1(e) General. ~~and of liquid chemicals the emergency source of electrical power is also to remain operable with the ship flooded to a final athwartships inclination up to a maximum of 30°.~~

1.10 Location and construction

1.10.8 The design of equipment is to enable ease of access to all parts requiring inspection or replacement in service.

Existing paragraphs 1.10.8 *to* 1.10.10 *have been renumbered* 1.10.9 *to* 1.10.11.

1.10.12 To allow ease of access, connectors are to be spaced far enough apart to permit connection and disconnection. At test points, adequate clearance is to be provided between connection points and controls to provide access for testing.

Existing paragraphs 1.10.11 *and* 1.10.12 *have been renumbered* 1.10.13 *and* 1.10.14.

1.14 Labels, signs and notices

1.14.1 Labels, signs and notices required by this Chapter are to be positioned in clearly visible locations which will not be obscured.

1.14.2 Labels, signs and notices are to be easy to read under the expected operating conditions. Character height in accordance with Table 2.1.2 will be considered to satisfy this requirement.

Table 2.1.2 Character height and viewing distance

Viewing distance (mm)	Minimum character height (mm)
Less than 500	2,3
500 – 1000	4,7
1000 – 2000	9,4
2000 – 4000	19
4000 – 8000	38

1.14.3 Controls, indicators and displays required by this Chapter are to be labelled to indicate their function. Labels are to be positioned in a manner that associates the label with the item being labelled.

1.14.4 Labels, signs and notices are to use short, clear messages. In general, warning signs and notices are to comprise:

- a signal word to convey the gravity of the risk (e.g. Danger, Warning or Caution);
- a statement of the nature and/or consequence of the hazard; and
- wherever practical, an instruction giving appropriate behaviour to avoid the hazard.

Existing sub-Sections 1.14 *to* 1.17 *have been renumbered* 1.15 *to* 1.18.

■ *Section 2*
Main source of electrical power

2.3 Starting arrangements

2.3.2 Where the emergency source of electrical power is required to be used to restore propulsion from a 'dead ship condition', the emergency generator is to be capable of providing initial starting energy for the propulsion machinery within 30 minutes of the 'dead ship condition'. The emergency generator capacity is to be sufficient for restoring propulsion in addition to supplying those services in ~~Section 3~~ 3.2.7(a), 3.2.7(b), 3.2.7(c) for passenger ships and 3.3.7(a), 3.3.7(b), 3.3.7(c) and 3.3.7(d) for cargo ships. *See* Pt 5, Ch 2,8.1.1 for dead ship condition starting arrangements.

■ *Section 5*
Supply and distribution

5.1 Systems of supply and distribution

5.1.2 For tankers intended for the carriage in bulk of oil, liquefied gases and other hazardous liquids having a flash point not exceeding 60°C (closed-cup test) only the following systems of generation and distribution are acceptable:
(a) d.c., two-wire, insulated;
(b) a.c., single-phase, two-wire, insulated;
(c) a.c., three-phase, three-wire, insulated;
(d) earthed systems, a.c. or d.c., limited to areas outside any hazardous space or zone, and arranged so that no current arising from an earth-fault in any part of the system could pass through a hazardous space or zone;
(e) earthed systems, complying with 5.1.1 and 5.5.7, provided the Government of the Flag State permits such an arrangement in accordance with the '*Equivalents*' provisions of SOLAS Chapter I, Regulation 5, *see* Ch 1,1.4 of ~~the *Rules and Regulations for the Construction and Classification of Ships for the Carriage of Liquid Chemicals in Bulk* (hereinafter referred to as~~ the Rules for Ships for Liquid Chemicals~~)~~ and/or ~~the *Rules and Regulations for the Construction and Classification of Ships for the Carriage of Liquefied Gases in Bulk* (hereinafter referred to as~~ the Rules for Ships for Liquefied Gases~~)~~, as appropriate, *see also* 13.1.2.

Earthed intrinsically-safe circuits are permitted to pass into and through hazardous spaces and zones.

5.3 Isolation and switching

5.3.4 Where arrangements are in place for automatic changeover between two or more supplies of electrical power in the event of failure of one supply, the arrangements are to be such that a fault in one feeder does not result in the loss of all supplies to the automatic changeover switch.

Existing paragraphs 5.3.4 *to* 5.3.9 *have been renumbered* 5.3.5 *to* 5.3.10.

■ *Section 6*
System design – Protection

6.13 Harmonic filters

6.13.1 Harmonic filters' final sub-circuits are to be protected individually against overload and short-circuit.

6.13.2 An alarm is to be initiated in the event of protective device operation.

6.13.3 Where parallel harmonic filters are used, an alarm is to be initiated in the event of current imbalance that could lead to failure of a harmonic filter.

■ *Section 7*
Switchgear and control gear assemblies

7.12 Instrument scales

7.12.5 In general, indications provided by instrumentation which are displayed digitally are not to change more frequently than twice per second.

■ *Section 8*
Rotating machines

8.1 General requirements

8.1.10 A high bearing temperature alarm is to be provided for generators of 100 kW and above, and electric propulsion motors, which are supplied with forced lubrication.

8.1.11 A low lubricating oil pressure alarm is to be provided for generators and electric propulsion motors that are supplied with forced lubrication.

8.1.12 A high lubricating oil temperature alarm is to be provided for electric propulsion motors that are supplied with forced lubrication.

8.1.13 For high voltage machines, the stator insulation system is to be of a type that has undergone sample testing in accordance with the following International Standards, or relevant alternatives acceptable to LR, to demonstrate its suitability for the operating voltage in the presence of an LR Surveyor:
(a) IEC 60894, *Guide for a test procedure for the measurement of loss tangent of coils and bars for machine windings*, at the insulation class rated temperature; and
(b) IEC 60034-15, *Impulse Voltage Withstand Levels of Form-wound Stator Coils for Rotating a.c. Machines*, with power-frequency voltage withstand testing conducted.

Test samples are to be representative in terms of the number and size of conductors, coil construction, combination of materials and manufacturing process.

8.1.14 For testing required by 8.1.10 on coils relating to global vacuum pressure impregnated systems, test samples representing the unimpregnated state and the impregnated state of the final winding and stator core are to be used as appropriate for testing.

8.6 Machine enclosure

8.6.1 Where ~~water~~ liquid-cooled heat exchangers are used in the machine cooling circuit there is to be provision ~~for the~~ to detect~~ion of water~~ leakage of the liquid, and the system is to be arranged so as to prevent the entry of ~~water~~ liquid into the machine.

8.8 Survey and testing

8.8.2 In the case of duplicate machines, type tests of temperature rise, excess current and torque and commutation taken on a machine identical in rating and in all other essential details may be accepted in conjunction with abbreviated tests on each machine. Type tests for propulsion machines will be specially considered, *see also* Section 15. For the abbreviated tests, each machine is to be run and is to be found electrically and mechanically sound and is to have a high voltage test and insulation resistance recorded.

~~*8.8.4* An impulse test is to be carried out on the coils of high voltage machines in order to demonstrate a satisfactory withstand level of the inter-turn insulation to voltage surges.~~

~~The test is to be carried out on all coils after they have been inserted in the slots and after wedging and bracing. Each coil shall be subjected to at least five impulses of injected voltage, the peak value of the injected voltage being given by the formula:~~

~~V_{peak} = 2,45V~~

~~where~~

~~V = rated line voltage r.m.s.~~

~~Alternative proposals to demonstrate the withstand level of inter-turn insulation will be considered.~~

8.8.4 Survey during manufacture, *see* 1.3, is to be conducted prior to testing of the completed machine and is to include inspection of rotor and stator assemblies to assess compliance with the constructional requirements of the relevant standards and this Section.

8.8.5 For high voltage machines, a description of rotor and stator insulation system application procedures (taping, impregnation, pressing and curing, etc.) with application process records, including details of checks and tests conducted to verify successful application, is to be made available to the LR Surveyor during manufacture, *see also* 8.1.10.

8.8.6 Routine impulse tests are to be carried out on the coils of high voltage machines in accordance with IEC 60034-15, *Impulse Voltage Withstand Levels of Form-wound Stator Coils for Rotating a.c. Machines*, in order to demonstrate a satisfactory withstand level of the inter-turn insulation to voltage surges. The test is to be carried out on all coils after they have been inserted in the slots and after wedging and bracing. Each coil shall be subjected to at least five impulses of injected voltage, the peak value of the injected voltage being given by the formula:

$V_{\text{peak}} = 2{,}45V$

where

V = rated line voltage r.m.s.

Alternative proposals to demonstrate the withstand level of inter-turn insulation will be considered.

■ *Section 9*
Converter equipment

9.1 Transformers

9.1.11 Transformers for propulsion power are to be provided with arrangements such that, in the event of excessive winding temperature, an alarm is initiated and:

- the load is reduced to a level commensurate with the cooling arrangements; or
- automatic shut-down of the transformer occurs.

~~*9.1.11*~~ *9.1.12* Where ~~water~~ liquid-cooled heat exchangers are used in transformer cooling circuits, there is to be provision ~~for the~~ to detect~~ion of water~~ leakage of the liquid, and the system is to be arranged so as to prevent the entry of ~~water~~ liquid into the transformer.

Existing paragraph 9.1.12 *has been renumbered* 9.1.13.

■ *Section 10*
Electric cables and busbar trunking systems (busways)

10.2 Testing

10.2.1 Routine tests, consisting of at least:

(a) measurement of electrical resistance of conductors;
(b) high voltage test, *see also* Section 20;
(c) insulation resistance measurement;
(d) for high voltage cables, partial discharge tests are to be made in accordance with the requirements of ~~the relevant publication or National Standard referred to in 10.1.2~~ IEC 60885-2, *Electrical test methods for electric cables. Part 2: Partial discharge tests*, or an acceptable National Standard, at the manufacturer's works prior to despatch.

Evidence of successful completion of routine tests is to be provided by the manufacturer, *see also* 1.3.3.

10.4 Operating temperature

~~**Table 2.10.2 Maximum rated conductor temperature**~~

~~Type of insulating compound~~	~~Maximum rated conductor temperature, °C~~	
	~~Normal operation~~	~~Short-circuit~~
~~Thermoplastics:~~		
~~– Based upon polyvinyl chloride or co-polymer of vinyl chloride and vinyl acetate~~	~~60~~	~~150~~
~~– Based upon polyethylene~~	~~60~~	~~130~~
~~Elastomeric or thermosettings:~~		
~~– Based upon ethylene propylene rubber or similar (EPM or EPDM)~~	~~85~~	~~250~~
~~– Based upon chemically crosslinked polyethylene~~	~~85~~	~~250~~
~~– Based upon silicon rubber~~	~~95~~	~~To be submitted~~
~~Mineral~~	~~95~~	~~To be submitted~~

Table 2.10.2 Maximum rated conductor temperature

Type of insulating compound	Maximum rated conductor temperature, °C	
	Normal operation	Short-circuit
Thermoplastic, based upon:		
Polyvinyl chloride or co-polymer of vinyl chloride and vinyl acetate	70	150
Elastomeric or thermosetting, based upon:		
Ethylene-propylene rubber or similar (EPM or EPDM)	90	250
High modulus or hard grade ethylene propylene rubber	90	250
Cross-linked polyethylene	90	250
Ethylene-propylene rubber or similar (EPM or EPDM) halogen free	90	250
High modulus or hard grade halogen-free ethylene propylene rubber	90	250
Halogen-free cross-linked polyethylene	90	250
Cross-linked polyolefin material for halogen-free cables	90	250
Silicone rubber	95	350
Halogen-free silicone rubber	95	350

10.5 Construction

10.5.3 Where electric cables are required to be of a 'fire resistant type', they are in addition to be easily distinguishable and comply with the performance requirements of the appropriate part of IEC 60331: *Tests for electric cables under fire conditions – Circuit integrity, when tested with a minimum flame application time of 90 minutes*, as follows:

- IEC 60331-1, *Tests for electric cables under fire conditions – Circuit integrity – Part 1: Test method for fire with shock at a temperature of at least 830°C for cables of rated voltage up to and including 0,6/1,0 kV and with an overall diameter exceeding 20 mm*.
- IEC 60331-21: *Procedures and requirements – Cables of rated voltage up to and including 0.6/1.0 kV*;
- IEC 60331-23: *Procedures and requirements – Electric data cables*;
- IEC 60331-25: *Procedures and requirements – Optical fibre cables*; or
- ~~IEC 60331-31: *Procedures and requirements – Cables of rated voltage up to and including 0.6/1.0 kV*, where the overall diameter of the cable exceeds 20 mm.~~

10.6 Conductor size

~~Table 2.10.3~~ **~~Electric cable current ratings, normal operation, based on ambient 45°C~~**

Nominal cross section	Continuous r.m.s current rating, in amperes								
	Thermoplastic, PVC, PE			EP rubber and crosslinked PE			Silicon rubber or mineral		
	Single Core	2-core	3- or 4-core	Single Core	2-core	3- or 4-core	Single Core	2-core	3- or 4-core
0,75	6	5	4	13	11	9	17	14	12
1	8	7	6	16	14	11	20	17	14
1,25	10	8	7	18	15	13	23	19	16
1,5	12	10	8	20	17	14	24	20	17
2	13	11	9	25	21	17	31	26	21
2,5	17	14	12	28	24	20	32	27	22
3,5	21	18	14	35	30	24	39	33	27
4	22	19	15	38	32	27	42	36	29
5,5	27	23	19	46	39	32	52	44	36
6	29	26	20	48	41	34	55	47	39
8	35	30	24	59	50	41	66	56	46
10	40	34	28	67	57	47	75	64	53
14	49	42	34	83	71	58	94	80	66
16	54	46	38	90	77	63	100	85	70
22	66	56	46	110	93	77	124	105	87
25	71	60	50	120	102	84	135	115	95
30	80	68	56	135	115	94	151	128	106
35	87	74	61	145	123	102	165	140	116
38	92	78	64	155	132	108	175	149	122
50	105	89	74	185	153	126	200	175	140
60	123	104	86	205	174	143	233	198	163
70	135	115	95	225	191	158	255	217	179
80	147	125	103	245	208	171	278	236	195
95	165	140	116	275	234	193	310	264	217
100	169	144	118	285	242	199	320	272	224
120	190	162	133	320	272	224	360	306	252
125	194	165	134	325	280	230	368	313	258
150	220	187	154	365	310	256	410	349	287
185	250	213	175	415	353	291	470	400	329
200	260	221	182	440	375	305	494	420	346
240	290	247	203	490	417	343	570	485	400
300	335	285	235	560	476	392	660	560	460

Table 2.10.3 Electric cable current ratings, normal operation, based on ambient 45°C

Nominal cross section (mm^2)	Continuous r.m.s current rating, in amperes								
	Thermoplastic, (70°C)			Elastomeric (90°C)			Elastomeric or thermosetting, based on silicon rubber (95°C)		
	Single Core	2 core	3 or 4 core	Single Core	2 core	3 or 4 core	Single Core	2 core	3 or 4 core
0,75	10	8	7	15	13	11	17	14	12
1	12	10	8	18	15	13	20	17	14
1,25	13	11	9	21	18	14	23	20	16
1,5	15	13	11	23	20	16	26	22	18
2	18	15	12	28	24	19	31	26	22
2,5	21	18	15	40	26	21	32	27	22
3,5	26	22	18	37	32	26	39	33	28
4	29	25	20	51	34	28	43	37	30
5,5	35	30	24	49	42	35	52	44	37
6	37	31	26	52	44	36	55	47	39
8	44	37	31	62	53	44	66	56	46
10	51	43	36	72	61	50	76	65	53
14	62	53	44	88	75	62	94	80	66
16	68	58	48	96	82	67	102	87	71
22	83	70	58	117	100	82	124	106	87
25	90	77	63	127	108	89	135	115	95
30	101	85	70	142	121	100	151	128	106
35	111	94	78	157	133	110	166	141	116
38	117	99	82	165	140	116	175	149	122
50	138	117	97	196	167	137	208	177	146
60	155	132	109	220	187	154	233	198	163
70	171	145	120	242	206	169	256	218	179
80	186	158	130	263	224	184	278	237	195
95	207	176	145	293	249	205	310	264	217
100	213	181	149	302	257	212	320	272	224
120	239	203	167	339	288	237	359	305	251
125	245	209	172	348	295	243	368	313	258
150	275	234	193	389	331	272	412	350	288
185	313	266	219	444	377	311	470	400	329
200	329	280	230	466	396	326	494	420	346
240	369	314	258	522	444	365	553	470	387
300	424	360	297	601	511	421	636	541	445

~~**Table 2.10.4 Electric cable current ratings, r.m.s. short-circuit current**~~

Nominal cross section	Fault current at 250°C duration			Fault current at 150°C duration			Fault current at 130°C duration		
	1,0 sec. kA	0,5 sec. kA	0,1 sec. kA	1,0 sec. kA	0,5 sec. kA	0,1 sec. kA	1,0 sec. kA	0,5 sec. kA	0,1 sec. kA
1	0,1	0,2	0,5	0,1	0,2	0,4	0,1	0,2	0,3
1,5	0,2	0,3	0,7	0,2	0,3	0,5	0,2	0,3	0,5
2,5	0,4	0,5	1,1	0,3	0,4	0,9	0,3	0,4	0,8
4	0,6	0,8	1,8	0,5	0,7	1,5	0,4	0,6	1,3
6	0,9	1,2	2,8	0,7	1,0	2,2	0,6	0,9	2,0
10	1,5	2,1	4,6	1,2	1,6	3,7	1,0	1,5	3,3
16	2,3	3,3	7,4	1,9	2,6	5,9	1,7	2,4	5,3
25	3,6	5,2	12	2,9	4,1	9,2	2,6	3,7	8,2
35	5,1	7,2	16	4,1	5,8	13	3,6	5,2	12
50	7,3	10	23	5,8	8,2	18	5,2	7,4	16
70	10	14	32	8,2	12	26	7,3	10	23
95	14	20	44	11	16	35	9,9	14	31
120	17	25	55	14	20	44	13	18	40
150	22	31	69	17	25	55	16	22	49
185	27	38	85	22	31	68	19	27	61
240	35	49	110	28	40	89	25	35	79
300	44	62	140	35	50	110	31	44	100

Table 2.10.4 Electric cable current ratings, r.m.s. short-circuit current

Nominal cross section (mm^2)	Fault current (kA) at 150°C			Fault current (kA) at 250°C			Fault current (kA) at 350°C		
	1 s duration	0,5 s duration	0,1 s duration	1 s duration	0,5 s duration	0,1 s duration	1 s duration	0,5 s duration	0,1 s duration
0,75	0,1	0,1	0,3	0,1	0,2	0,3	0,1	0,2	0,4
1	0,1	0,2	0,3	0,1	0,2	0,5	0,2	0,2	0,5
1,25	0,1	0,2	0,4	0,2	0,3	0,6	0,2	0,3	0,7
1,5	0,2	0,2	0,5	0,2	0,3	0,7	0,3	0,4	0,8
2	0,2	0,3	0,7	0,3	0,4	0,9	0,3	0,5	1,1
2,5	0,3	0,4	0,9	0,4	0,5	1,1	0,4	0,6	1,4
3,5	0,4	0,5	1,2	0,5	0,7	1,6	0,6	0,8	1,9
4	0,4	0,6	1,4	0,6	0,8	1,8	0,7	1,0	2,2
5,5	0,6	0,8	1,9	0,8	1,1	2,5	0,9	1,3	3,0
6	0,7	0,9	2,1	0,9	1,2	2,7	1,0	1,5	3,2
8	0,9	1,2	2,8	1,1	1,6	3,6	1,4	1,9	4,3
10	1,1	1,5	3,5	1,4	2,0	4,5	1,7	2,4	5,4
14	1,5	2,2	4,8	2,0	2,8	6,3	2,4	3,4	7,6
16	1,7	2,5	5,5	2,3	3,2	7,2	2,7	3,9	8,7
22	2,4	3,4	7,6	3,1	4,5	10,0	3,8	5,3	11,9
25	2,7	3,9	8,6	3,6	5,1	11,3	4,3	6,0	13,5
30	3,3	4,6	10,4	4,3	6,1	13,6	5,1	7,3	16,2
35	3,8	5,4	12,1	5,0	7,1	15,8	6,0	8,5	18,9
38	4,1	5,9	13,1	5,4	7,7	17,2	6,5	9,2	20,6
50	5,5	7,7	17,3	7,2	10,1	22,6	8,6	12,1	27,1
60	6,5	9,3	20,7	8,6	12,1	27,1	10,3	14,5	32,5
70	7,6	10,8	24,2	10,0	14,2	31,7	12,0	16,9	37,9
80	8,7	12,3	37,6	11,4	16,2	36,2	13,7	19,4	43,3
95	10,4	14,7	32,8	13,6	19,2	43,0	16,3	23,0	51,4
100	10,9	15,4	34,5	14,3	20,2	45,2	17,1	24,2	54,1
120	13,1	18,5	41,4	17,2	24,3	54,3	20,5	29,0	64,9
125	13,6	19,3	43,1	17,9	25,3	56,6	21,4	30,2	67,6
150	16,4	23,2	51,8	21,5	30,4	67,9	25,7	36,3	81,2
185	20,2	28,6	63,9	26,5	37,4	83,7	31,7	44,8	100,1
200	21,8	30,9	69,0	28,6	40,5	90,5	34,2	48,4	108,2
240	26,2	37,0	82,8	34,3	48,6	108,6	41,1	58,1	129,9
300	32,7	46,3	103,6	42,9	60,7	135,7	51,3	72,6	162,3

~~**Table 2.10.5 Correction factors**~~

~~Insulation material~~	~~Correction factor for ambient air temperature of °C~~										
	~~35~~	~~40~~	~~45~~	~~50~~	~~55~~	~~60~~	~~65~~	~~70~~	~~75~~	~~80~~	~~85~~
~~PVC, Polyethylene~~	~~1,29~~	~~1,15~~	~~1,00~~	~~0,82~~	~~–~~	~~–~~	~~–~~	~~–~~	~~–~~	~~–~~	~~–~~
~~EPR, XLPE~~	~~1,12~~	~~1,06~~	~~1,00~~	~~0,94~~	~~0,87~~	~~0,79~~	~~0,71~~	~~0,61~~	~~0,50~~	~~–~~	~~–~~
~~Mineral, Silicon rubber~~	~~1,10~~	~~1,05~~	~~1,00~~	~~0,95~~	~~0,89~~	~~0,84~~	~~0,77~~	~~0,71~~	~~00,63~~	~~0,55~~	~~0,45~~

Table 2.10.5 Correction factors

Insulation material	Correction factor for ambient air temperature of °C										
	35	40	45	50	55	60	65	70	75	80	85
Thermoplastic (70°C)	1,18	1,10	1,00	0,89	0,77	0,63	—	—	—	—	—
Elastomeric or thermosetting (90°C)	1,10	1,05	1,00	0,94	0,88	0,82	0,74	0,67	0,58	0,47	—
Elastomeric or thermosetting, based on silicone bubber (95°C)	1,10	1,05	1,00	0,95	0,89	0,84	0,77	0,71	0,63	0,55	0,45

■ *Section 11*
Batteries

11.5 Ventilation

11.5.1 Battery compartments and boxes are to be ventilated to avoid accumulation of dangerous concentrations of flammable gas. The ventilation openings are to be of a non-closeable type, with the exception of closing devices in accordance with 11.5.2, and a permanent notice is to be prominently displayed adjacent to them, stating:

> THIS VENTILATOR OPENING IS NOT TO BE CLOSED OR BLOCKED AT ANY TIME – EXPLOSIVE GAS.

11.5.2 Closing devices in battery compartment ventilation openings are to be provided with a means to be locked open. A permanent notice is to be prominently displayed adjacent to each one to make clear that the closing device is only to be closed in the event of a fire.

Existing paragraphs 11.5.2 *to* 11.5.10 *have been renumbered* 11.5.3 *to* 11.5.11.

■ *Section 15*
Electric propulsion

15.1 General

15.1.4 Propulsion motors, generators and converters are to be provided with means to prevent the accumulation of moisture and condensate when operating at low power levels, or when idle.

15.2 System design and arrangement

15.2.1 In general, for a ship to be assigned an unrestricted service notation, it is to have two independently driven propellers or other propulsion devices, each connected with at least one electric motor, where these form the sole means of propulsion.

15.2.2 For vessels where a propulsion device driven by electric motors is proposed as the sole means of propulsion, at least two effective, independent electric propulsion motors are to be provided and the system is to be designed in accordance with Pt 7, Ch 15. The risk management is to identify components where a failure could cause loss of propulsion power or other essential services and the proposed arrangements for preventing and mitigating the effects of such a failure.

~~15.2~~ 15.3 Power requirements

Existing paragraphs 15.2.1 *to* 15.2.6 *have been renumbered* 15.3.1 *to* 15.3.6.

15.3.7 Where a central power generation system is employed, means are to be provided to connect available generator sets to meet the power requirement of the electric propulsion system. Arrangements are to be in place to prevent generator sets being automatically disconnected during ship manoeuvres.

15.3.8 Where forced cooling is used on propulsion motors it is to be possible to operate the motor at a defined reduced power level in the event of failure of the forced cooling.

15.3.9 Total harmonic distortion of the a.c. voltage waveform up to 10 per cent on electric propulsion circuits, not directly connected to the main source of electrical power, may be considered where details are submitted which demonstrate that the equipment and systems are capable of operating under such conditions.

~~15.3~~ 15.4 Propulsion control

Existing paragraphs 15.3.1 *to* 15.3.5 *have been renumbered* 15.4.1 *to* 15.4.5.

~~*15.3.6*~~ *15.4.6* Control ~~stations~~, alarm and safety systems for the propulsion system are to satisfy the requirements of Chapter 1.

Existing paragraphs 15.3.7 *and* 15.3.8 *have been renumbered* 15.4.7 *and* 15.4.8.

15.4.9 Means are to be provided to identify the cause of propulsion motor power limitation or automatic reduction (e.g. excessive load torque, cooling failure, high temperature, power availability).

Existing paragraph 15.3.9 *has been renumbered* 15.4.10.

~~*15.3.10* The propulsion control may be in analogue or digital form, which is to be developed using a systematic design procedure incorporating verification and validation methods to ensure successful implementation of the requirements listed above. A quality plan giving evidence of compliance with this requirement is to be submitted when requested.~~

15.4.11 Control systems are not to share hardware or data communication links with control, safety and alarm systems not associated with propulsion control, *see also* Ch 1,2.11.

~~15.4~~ 15.5 Protection of propulsion system

~~*15.4.1*~~ *15.5.1* Provision is to be made for protection against severe overloads, and electrical faults likely to result in damage to plant.

15.5.2 Propulsion motors are to be capable of withstanding, without damage, the thermal and mechanical effects of a short-circuit at the terminals.

15.5.3 Electric motors of podded propulsion units, and/or having permanent magnet excitation, are to be provided with a protective device which, in the event of a short-circuit in the motor or in the cables between the motor and its circuit breaker, will instantaneously open the circuit breaker and, in motors with electromagnetic excitation, de-excite the motor. Motors with permanent magnet main excitation are to be provided with means to prevent further damage as a result of continued rotation after disconnection (e.g. shaft brake).

~~15.4.2~~ 15.5.4 ~~The main propulsion circuits are to be provided with means for detecting earth faults.~~ Safeguards for protecting propulsion equipment against damage resulting from earth faults are to be as specified by the equipment manufacturer. Where the fault current flowing is liable to cause damage to the electrical equipment there are to be arrangements for interrupting the current automatically.

~~15.4.3~~ 15.5.5 For the protection of electrical equipment and cables against overvoltages means are to be provided for limiting the induced voltage when field windings, and other inductive circuits are opened. Protective resistors and devices are to be sized to cater for the likely extreme operating conditions.

15.5.6 An alarm is to be initiated when the excitation system of electric generators providing propulsion power is overloaded such that damage due to heating could occur in the generator or its cabling.

~~15.4.4~~ 15.5.7 Where, on stopping or reversing the propeller, regenerated energy is produced by the propulsion motor this is not to cause a dangerous increase of speed in the prime mover or a dangerous overvoltage condition on the supply system. Where a central power generation system is used then the voltage and frequency fluctuations are not to exceed the limits given in 1.7.

15.5.8 Dynamic braking resistors are to be suitably rated for their expected operation.

15.5.9 Propulsion converters are to be capable of withstanding, without damage, the thermal and mechanical effects of a short-circuit at the terminals or connection to a propulsion motor with a stalled or locked rotor.

15.5.10 Loss of flow of air or liquid cooling of propulsion converters, where used, is to initiate an alarm at an attended control position. Loss of flow of air or liquid cooling is not to result in immediate damage to the propulsion converter, *see* 9.2.4.

15.5.11 Alarms and safeguards for electric propulsion equipment are indicated in Table 2.15.1.

Table 2.15.1 Electric propulsion equipment: Alarms and safeguards

Item	Alarm	Note
Electric propulsion equipment ventilation and cooling medium temperature	High	*See* 15.1.2 and 15.3.9
Electric propulsion transformer winding temperature	High	*See* 9.1.11
Electric propulsion generator excitation	Overload	*See* 15.5.6
Electric propulsion generators and motors winding temperature	High	*See* 15.1.3
Electric propulsion generator and motor lubricating oil temperature	High	*See* 8.1.10
Electric propulsion generator and motor lubricating oil supply pressure	Low	*See* 8.1.11
Power limitation	—	Indication, *see* 15.4.8 and 15.4.9

~~15.5~~ 15.6 Instruments

~~15.5.1~~ 15.6.1 The main control station is to be provided with the following instruments:

(a) a.c. systems:
  (i) an ammeter for each generator, ~~and~~ propulsion motor and propulsion transformer primary; voltmeter, wattmeter and frequency meter for each generator and ammeter for each excitation circuit; and
  (ii) a temperature indicator for each generator, propulsion transformer and propulsion motor windings and bearings, the indicator is to read stator winding temperature of the rotating machines, and cooling system temperature.

(b) d.c. systems:
~~a voltmeter and ammeter for each generator and propulsion motor;~~
~~an ammeter for each excitation circuit.~~
  (i) a voltmeter and ammeter for each generator and propulsion motor; and
  (ii) an ammeter for each excitation circuit.

~~15.5.2~~ 15.6.2 Each control station is to be provided with instruments to indicate:

(a) propeller speed;
(b) direction of rotation for a fixed pitch propeller or pitch position for a controllable pitch propeller; ~~and~~
(c) visual indication of power limitation~~.~~; and
(d) indication of station in control.

■ *Section 18*
Ship safety systems

18.1 Watertight doors

~~*18.1.2* For passenger ships, where the sources for opening and closing the watertight doors have electric motors, unless an independent temporary source of stored energy is provided, the electric motors are to be capable of being automatically supplied from the transitional source of emergency electrical power.~~

Existing paragraphs 18.1.3 *to* 18.1.13 *have been renumbered* 18.1.2 *to* 18.1.12.

18.2 Stern and side shell doors and bow and inner doors

18.2.1 The requirements of 18.2.2 to 18.2.14 apply to all stern and side shell doors, bow doors and inner doors, giving access to vehicle decks, and subdivision doors, in accordance with Pt 4, Ch 2,9, on all ships except where otherwise stated in 18.2.11 and 18.2.12.

Existing paragraphs 18.2.1 *to* 18.2.10 *have been renumbered* 18.2.2 *to* 18.2.11.

18.2.12 Bow doors and inner doors, giving access to vehicle decks, and subdivision doors are to be provided with an arrangement for remote control from a position above the freeboard deck, providing centralised control for:

(a) the closing and opening of the doors; and
(b) associated securing and locking devices.

Existing paragraph 18.2.11 *has been renumbered* 18.2.13.

18.2.14 A drainage system is to be arranged in the area between bow door and ramp or, where no ramp is fitted, between the bow door and inner door. The system is to be equipped with an audible alarm function on the navigation bridge being set off when the water levels in these areas exceed 0,5 m.

~~18.2.12~~ 8.2.15 The additional requirements of ~~18.2.13 to 18.2.17~~ 18.2.16 to 18.2.22 apply to stern and side shell doors in the boundaries of special category spaces or ro-ro cargo spaces through which such spaces may be flooded, and to bow doors and inner doors. For cargo ships, where no part of the door is below the uppermost waterline and the area of the door opening is not greater than 6 m^2, then the requirements of ~~18.2.13 to 18.2.17~~ 18.2.16 to 18.2.22 need not be applied.

Existing paragraphs 18.2.13 *to* 18.2.16 *have been renumbered* 18.2.16 *to* 18.2.19.

18.2.20 Television surveillance arrangements are to be provided to enable the positions of bow doors and inner doors, and a sufficient number of their closing devices, to be monitored from the navigation bridge and the engine control room, or an equivalent attended position. The television surveillance arrangements are also to allow leakage through the bow doors and inner doors to be assessed from the same positions in the event of leakage through the doors. Special consideration is to be given to the lighting and contrasting colour of objects under surveillance.

~~18.2.17~~ 18.2.21 For passenger ships, television surveillance arrangements are to be provided to allow leakage through stern and side shell doors below the freeboard deck to be assessed from the navigation bridge and the engine control room, or equivalent attended position.

18.2.22 The electrical power supply for surveillance lighting is to be independent of any electrical power supply for operating, securing and locking the doors.

~~18.3 Bow and inner doors~~

Existing paragraphs 18.3.1 *to* 18.3.16 *have been deleted*.

~~18.4~~ 18.3 Subdivision doors on vehicle decks

~~18.4.1~~ 18.3.1 Where subdivision doors are provided on passenger ship vehicle decks in accordance with Pt 4, Ch 2,9, the control and monitoring arrangements for these doors are to generally comply with ~~18.3~~ 18.2.

~~18.5~~ 18.4 Bilge pumps

~~18.5.1~~ 18.4.1 Where the bilge pumps for the holds of open-top container ships are electrically driven one pump is to be supplied from the emergency switchboard, the remaining pumps are to be supplied from the main source of electrical power, independent of the emergency switchboard.

■ *Section 20*
Testing and trials

20.2 Trials

20.2.4 It is to be demonstrated that the Rules have been complied with in respect of:

(a) satisfactory performance of each generator throughout a run at full rated load;
(b) temperature of joint, connections, circuit-breakers and fuses;
(c) the operation of engine governors, synchronising devices, overspeed trips, reverse-current, reverse-power and over-current trips and other safety devices;
(d) voltage regulation of every generator when full rated load is suddenly thrown off and when starting the largest motor connected to the system;
(e) voltage drop;
(f) harmonic distortion of the voltage waveform;
~~(e)~~ (g) satisfactory parallel operation, and kW and KVA load sharing of all generators capable of being operated in parallel at all loads up to normal working load;
~~(f)~~ (h) all essential and other important equipment are to be operated under service conditions, though not necessarily at full load or simultaneously, for a sufficient length of time to demonstrate that they are satisfactory;
~~(g)~~ (j) propulsion equipment is to be tested under working conditions and operated in the presence of the Surveyors and to their satisfaction. The equipment is to have sufficient power for going astern to secure proper control of the ship in all normal circumstances. In passenger ships the ability of the machinery to reverse the direction of thrust of the propeller in sufficient time, under normal manoeuvring conditions, and so bring the ship to rest from maximum ahead service speed, is to be demonstrated at the sea trial; and
(k) operation of power management for electric propulsion.

~~*20.2.5* Voltage drop is to be measured, where necessary, to verify that this is not in excess of that specified in 1.7.~~

20.2.5 Where necessary, measurements are to be taken as part of the trials specified in 20.2.4(c), (d), (e) and (f) to verify that the installation will provide a quality of power supply in accordance with the values listed in 1.7.

Part 7, Chapter 9

Navigational Arrangements and Integrated Bridge Systems

Effective date 1 July 2011

■ *Section 2*
Physical conditions

2.2 Environment

2.2.5 Entrance doors to the wheelhouse are to be securable from the inside, and operable with one hand. Bridge wing doors are not to be self-closing, and are to be provided with means to hold them open. For ships required to comply with the *Rules and Regulations for the Construction and Classification of Ships for the Carriage of Liquefied Gases in Bulk*, the sealing mechanism of each door is to be such that a rapid and efficient gas and vapour tightening can be ensured.

■ *Section 3*
Workstations

3.2 Voyage planning workstation

3.2.1 A voyage planning workstation is to be provided at which the following facilities are available:

- Chart ~~table with instruments~~ display and information facilities.
- Position-fixing systems.
- Time indication.

3.2.3 ~~The chart table is~~ An Electronic Chart Display and Information System (ECDIS) is to be provided. Chart tables for paper charts, where provided, are to be large enough to accommodate all chart sizes normally used internationally for maritime traffic and ~~is~~ are to have facilities for illuminating the chart, *see also* 2.3.8.

■ *Section 4*
Systems

4.1 Alarm and warning systems

4.1.4 In the event that any alarm initiated by navigation equipment on the navigating bridge has not been acknowledged on the bridge within a period of 30 seconds, a visual and audible alarm is to be initiated immediately to warn the appointed back-up navigator and/or the Master.

4.1.5 In the event that the alarm required by 4.1.4 is not acknowledged, the system is to initiate an alarm at the locations of further crew members capable of taking corrective actions following a time delay sufficient to allow the Master or back-up navigator to reach the bridge. The time interval is to be adjustable between 90 seconds up to a maximum of 3 minutes. In ships, other than passenger ships, the alarm to warn the further crew members may be initiated at the same time as the alarm to warn the Master and back-up navigator.

4.1.6 The functionality specified in 4.1.4 and 4.1.5 may be incorporated in the watch safety system required by 4.2, or in another fixed system.

■ *Section 5*
Integrated Bridge Navigation System – IBS notation

5.2 General requirements

5.2.1 For assignment of the notation **IBS**, in addition to satisfying the other requirements of this Section:

(a) the layout of the bridge and the equipment located on the bridge is to satisfy the requirements of a relevant international or national ergonomic or human-centred design Standard or an acceptable equivalent; or

(b) the notation **NAV1** is also to be assigned and the layout of the bridge and the equipment on the bridge are to satisfy the requirements Sections 1 to 4; or

(c) where the bridge is not intended to operate a periodic one man watch, the layout of the bridge and the equipment on the bridge are to satisfy the requirements of Sections 1 to 4, with the exception that the requirements of ~~4.2 and~~ 4.3 may be relaxed.

5.3 Equipment

5.3.12 The integrated bridge system is to incorporate a ~~an electronic chart~~ display, which combines simultaneously ~~a~~ the ECDIS high resolution colour representation of a nautical chart with a continuously updated record of own ship's position, pre-planned track, and radar targets in the vicinity. The entire tactical situation is to be displayed for the navigating officer in such a way that any risk from approaching, overtaking or crossing vessels may be assessed. Factors affecting the vessel's freedom to manoeuvre, such as water depths, channel boundaries, separation zones and other traffic are to be shown on the display.

Part 7, Chapter 14

On-shore Power Supplies

Effective date 1 July 2011

■ *Section 2*
Essential features

2.1 General requirements

2.1.6 Consideration may be given to arrangements that are considered by LR to provide an equivalent level of safety ~~or that comply with the provisions of a relevant standard acceptable to LR~~. Evidence demonstrating compliance with IEC PAS 60092-510, *Electrical installations in ships – Special features: High-voltage shore connection systems*, or other relevant National Standards may be submitted for consideration of acceptability by LR.

■ *Section 3*
Electrical connection

3.1 General

3.1.7 For high voltage connections, means are to be provided ~~to verify the continuity of the earth connection referred to in 3.1.6~~, as applicable to the design, to either:

(a) permit termination of circuits used by external power supply equipment to monitor the continuity of the earth connection referred to in 3.1.6; or

(b) monitor the continuity of the earth connection referred to in 3.1.6, *see* 5.3.8.

3.2 Connection equipment

3.2.11 Effective means are to be provided to prevent the accumulation of moisture and condensation within equipment enclosures. Failure of heaters and/or ventilation fans provided to satisfy this requirement is to activate an alarm at a machinery control station that is attended while connected to an external power supply. The installation of open deck enclosures for high voltage connections is to be minimised to that required for the Defined Operations; a technical justification, including proposed degree of protection ratings, is to be included in the submission required by 1.4.8.

3.3 Connection cables, plugs and socket-outlets

~~*3.3.10* Connection Equipment cables are to be of a type, and installed in a manner such as to minimise the risk of short-circuit when correctly applied.~~

3.3.10 Connection Equipment power cables are to be Type Approved in accordance with LR's *Type Approval System Test Specification Number 3* or, alternatively, surveyed by the Surveyors during manufacture and testing to assess compliance with 3.3.6 and application of an acceptable quality management system. Connection equipment cables are to be installed so as to minimise the risk of short-circuit when correctly applied.

3.4 Containers

3.4.1 Connection Equipment installed in removable containers is to satisfy the additional requirements of this sub-Section.

3.4.2 Containers are to be for the ship's exclusive use and are to be provided with a permanent notice indicating the ship name and IMO Ship Number.

3.4.3 Container locations are to be designated and identified in the plans required by 1.4.4 and provided with fixings that are suitable for the Defined Operations. Procedures for container fixing, use and movement are to be included in the Operating Manuals.

3.4.4 The container type is to be a steel, closed type, weatherproof construction sufficient to prevent damage during expected use, for example during loading and unloading.

3.4.5 Measures necessary to prevent movement of the container when the container has electrical cables connected are to be provided.

3.4.6 Suitable protection is to be provided to prevent damage to Connection Equipment at the container entry points.

3.4.7 Suitable safe access is to be provided to the container for the Defined Operations, inspection and maintenance.

3.4.8 Container entry points are to be provided with suitable sealing arrangements to prevent the ingress of water into the container.

3.4.9 Containers are to be provided with effective means of ventilation. Where a container ventilation fan is provided, alarms are to be provided in accordance with 3.2.11.

3.5 High voltage in the presence of personnel

3.5.1 The Defined Operations are, as far as is practical, not to require personnel to be in the vicinity of high voltage equipment when it is energised.

3.5.2 For high voltage:

(a) switchgear and control gear assemblies;
(b) cable reels, cranes and gantries; and
(c) mounting enclosures for socket-outlets used to connect flexible cables to fixed connections;

arrangements are to be made to protect personnel in the event of gases, arc flash or vapours escaping under pressure as the result of arcing due to an internal fault. Where the Defined Operations require personnel to be in the vicinity of such equipment when it is energised, this may be achieved by an assembly that has been tested in accordance with Annex A of IEC 62271-200 and qualified for classification IAC (internal arc classification), or equivalent.

■ *Section 5*
Control and monitoring

5.1 General

5.1.12 If, depending upon the in-port shipboard work organisation, no machinery control stations are continuously attended while connected to an external power supply, then alarm transfer arrangements that activate an audible indication to warn relevant duty personnel of alarm initiation may be accepted. An audible warning from any portable devices is to be provided in the event of loss of the wireless link.

Table 14.5.1 Additional alarms and associated safeguards

Item	Alarm	Note
Presence of voltage on connections		Indicators in accordance with 3.1.9.
Transfer of load	Time limit exceeded	Return to previous operating state to be indicated, *see* 4.1.5.
Ship power restoration	Activation	*See* 4.5.2.
Arrangements to ensure main and auxiliary machinery availability	Failure	When shut-down. *See* 5.1.9.
Applied connection equipment status	Changed	Indication to be provided also. *See* 5.2.4 and 5.2.5.
Connection equipment	Close proximity to water level	*See* 5.2.6.
Heaters and/or ventilation fans	Failure	*See* 3.2.11 and 3.4.9
Connection equipment tension	High	Emergency Shut-Down to be activated. *See* ~~5.3.10~~ 5.3.11.
Plug connectors	Withdrawal	
~~Connection cable, for connection ratings~~	~~Short-circuit~~	
Earth connection, if required. *See* 5.3.9	Loss of continuity	
Manual disconnection	Activation	
Plug and socket-outlet, if required. *See* ~~5.3.5~~ 5.3.6	Not in locked position	
Switchgear enclosure mounted socket-outlets	Arc fault detection	

5.3 Emergency Shut-Down

~~*5.3.3* For high voltage connections, the Connection Equipment power connections are also to be discharged so that they are safe to touch following the isolation from ship and shore electrical power supplies required by 5.3.2 in as short a time as practicable. Where earthing of connecting external equipment by ship equipment would not be permitted by the authorities responsible for the external equipment, details are to be submitted prior to connection for consideration. The submission is to detail alternative proposals for personnel protection and Connection Equipment power conductors discharge in the event of activation of the Emergency Shut-Down facilities.~~

5.3.3 High-voltage Connection Equipment is to be either:

(a) provided with permanent arrangements for manual discharging and routed to prevent personnel access to live connection cables and connection points by barriers and/or adequate distance(s) under expected operating conditions; or

(b) automatically discharged so that it is safe to touch with immediate initiation of switching device closure following the isolation from ship and shore electrical power supplies required by 5.3.2.

5.3.4 For ships that are intended to connect in ports where Connection Equipment may move into a hazardous area associated with the terminal or port area as a result of the ship inadvertently leaving the berthed position (slipping/breaking of moorings, etc.), this condition is to be included in the Design Statement. The arrangements are to comply with 5.3.3(b) and, additionally, other electrically powered connection equipment that is not intrinsically safe is to be arranged for automatic isolation.

Existing paragraphs 5.3.4 *and* 5.3.5 *have been renumbered* 5.3.5 *and* 5.3.6.

~~*5.3.6*~~ *5.3.7* For high-voltage ~~connections~~ connection points on board where the means of locking together plugs and socket-outlets required by 3.3.4 are not interlocked to prevent removal from the locked position when the Connection Equipment power connections are not discharged so that they are safe to touch, the Emergency Shut-Down facilities described in 5.3.2 are to be activated when connected plugs are moved from the locked position. Consideration may be given to relaxing this requirement when evidence is submitted which demonstrates that appropriate controls and procedures acceptable to LR are in place to control personnel access plugs and socket-outlets.

Existing paragraphs 5.3.7 *has been renumbered* 5.3.8.

~~*5.3.8* Where shipboard cables are extended to the external electrical power supply connection points then a protective device is to be provided which will activate the Emergency Shut-Down facilities described in 5.3.2 in the event of a short-circuit in the shipboard cables from the connection cubicle when connected to an external power supply in accordance with 3.1.10.~~

5.3.9 Where 3.1.7(b) applies, the Emergency Shut-Down facilities described in 5.3.2 are to be activated in the event of loss of earth connection continuity being detected.

Existing paragraphs 5.3.9 *and* 5.3.10 *have been renumbered* 5.3.10 *and* 5.3.11.

■ *Section 6*
Testing, trials and surveys

6.1 General

6.1.1 The testing and trials required by 6.1.2 to ~~6.1.4~~ 6.1.5 are to be successfully completed to the Surveyor's satisfaction before **OPS** notation may be assigned. Where appropriate test facilities cannot be provided, trials are likely to require the additional co-operation of a port facility with a suitable external electrical power supply and the ability to operate the defined services to be supplied during these trials and allow the testing described to be conducted.

6.1.2 Electrical and control engineering equipment is to be surveyed at manufacturer's works and undergo survey and operational trials on board in accordance with the approved test schedules and applicable testing requirements in Pt 6, Ch 1 and Ch 2. ~~*See also* Pt 6, Ch 2,1.3.5.~~

6.1.3 In addition to 6.1.2, the following Connection Equipment, where applicable, is to be surveyed by the Surveyors during manufacture and testing:

- filters;
- converters; and
- slip ring assemblies.

Existing paragraphs 6.1.3 *to* 6.1.5 *have been renumbered* 6.1.4 *to* 6.1.6.

Part 8, Chapter 2

Ice Operations – Ice Class

Effective date 1 July 2011

■ *Section 3*
General machinery requirements for navigation in ice – All Ice Classes

3.2 Materials for propellers

3.2.4 Forged steel load transmitting components of controllable pitch propellers are to be manufactured, tested, and certified in accordance with Ch 5,1 and Ch 5,2 of the Rules for Materials. Impact tests are to be carried out at minus 10°C and the average energy value is to be not less than ~~27 J~~ 20 J.

Cross-references

Section numbering in brackets reflects any Section renumbering necessitated by any of the Notices that update the current version of the Rules for Ships.

Part 5, Chapter 2

1.1.7	*Reference* 8.1 *now reads* 8.11
2.3.2	*Reference* 8.1.1 *now reads* 8.11.1
*8.1.2 (**8.11.2**)*	*Reference* 8.1.1 *now reads* 8.11.1
*8.1.5 (**8.11.5**)*	*Reference* 8.1.3 *now reads* 8.11.3
	Reference 8.1.4 *now reads* 8.11.4
*8.4.1 (**8.13.1**)*	*Reference* 8.3 *now reads* 8.12
*8.4.4 (**8.13.4**)*	*Reference* 8.4.1 *now reads* 8.13.1
	Reference 8.4.3 *now reads* 8.13.3
*8.4.6 (**8.13.6**)*	*Reference* 8.4.1 *now reads* 8.13.1
	Reference 8.4.2 *now reads* 8.13.2
*8.5.5 (**8.14.5**)*	*Reference* 8.5.2 *now reads* 8.14.2
	Reference 8.5.3 *now reads* 8.14.3
*8.5.6 (**8.14.6**)*	*Reference* 8.4.2 to 8.4.5 *now reads* 8.13.2 to 8.13.5
*8.6.2 (**8.15.2**)*	*Reference* 8.6.1 *now reads* 8.15.1
15.3.2(a)	*Reference* Pt 6, Ch 1,2.12.2 *now reads* Pt 6, Ch 1,2.13.2
15.3.2(b)	*Reference* Pt 6, Ch 1,2.13.4 *now reads* Pt 6, Ch 1,2.14.4
	Reference Pt 6, Ch 1,2.13.5 *now reads* Pt 6, Ch 1,2.14.5
15.3.2(c)	*Reference* 2.13.5 *now reads* 2.14.5
15.6.1	*Reference* Pt 6, Ch 1,2.12.2 *now reads* Pt 6, Ch 1,2.13.2
	Reference 2.12.7 *now reads* 2.13.7

Part 5, Chapter 9

8.1.5	*Reference* Pt 6, Ch 2,15.3.7 *now reads* Pt 6, Ch 2,15.4.7
8.1.6(b)	*Reference* Pt 6, Ch 1,2.12 *now reads* Pt 6, Ch 1,2.13
8.1.7	*Reference* Pt 6, Ch 1,2.13 *now reads* Pt 6, Ch 1,2.14

Part 5, Chapter 14

3.3.2	*Reference* Ch 2,8.1 *now reads* Ch 2,8.11

Part 5, Chapter 20

5.2.1	*Reference* Pt 6, Ch 2,15.2.5 *now reads* Pt 6, Ch 2,15.3.5

Part 5, Chapter 23

2.1.3	*Reference* Pt 6, Ch 2,1.14 *now reads* Pt 6, Ch 2,1.15
	Reference 1.15 *now reads* 1.16
4.1.2	*Reference* Pt 6, Ch 2,1.14 *now reads* Pt 6, Ch 2,1.15

Part 6, Chapter 1

1.2.1	*Reference* 1.2.7 *now reads* 1.2.8
1.3.2	*Reference* 2.12.3 *now reads* 2.13.3
2.10.2	*Reference* 2.13 *now reads* 2.14
2.10.9	*Reference* 2.12.6 *now reads* 2.13.6
*2.12.1 (**2.13.1**)*	*Reference* 2.12.2 to 2.12.9 *now reads* 2.13.2 to 2.13.9
*2.13.1 (**2.14.1**)*	*Reference* 2.13.2 *now reads* 2.14.2
2.10.1	*Reference* 2.12 *now reads* 2.13
	Reference 2.13 *now reads* 2.14
2.10.5	*Reference* 2.12.3 *now reads* 2.13.3
2.10.6	*Reference* 2.12.2 *now reads* 2.13.2
	Reference 2.12.9 *now reads* 2.13.9
3.2.7	*Reference* 8.4 *now reads* 8.13
3.5.6(d)	*Reference* 3.1.7 *now reads* 3.1.9
Table1.3.4	*Reference* 3.1.7 *now reads* 3.1.9 (twice)
	Reference 3.1.9 *now reads* 3.1.11
	Reference 3.1.10 *now reads* 3.1.12
Table1.3.5	*Reference* 3.1.7 *now reads* 3.1.9 (twice)
	Reference 3.1.9 to 3.1.10 *now reads* 3.1.11 to 3.1.12
3.5.8	*Reference* 3.1.8 *now reads* 3.1.10
3.6.5(d)	*Reference* 3.1.7 *now reads* 3.1.9
3.6.7	*Reference* 3.1.8 *now reads* 3.1.10
*3.15.1 (**3.14.1**)*	*Reference* 3.15.2 to 3.15.6 *now read* 3.14.2 to 3.14.6
	Reference Table 1.3.12 *now reads* Table 1.3.11
6.1.2	*Reference* 2.13.5 *now reads* 2.14.5
6.2.3	*Reference* 2.12.7 *now reads* 2.13.7

Part 6, Chapter 2

1.2.1	*Reference* 1.2.15 *now reads* 1.2.16
	Reference 1.2.18 *now reads* 1.2.19
1.5.11	*Reference* 8.5 *now reads* 8.14
1.13.3	*Reference* 1.14 *now reads* 1.15
1.13.4	*Reference* 1.14 *now reads* 1.15
*1.14.2 (**1.15.2**)*	*Reference* 1.14.1 *now reads* 1.15.1
*1.14.3 (**1.15.3**)*	*Reference* 1.14.1 *now reads* 1.15.1
*1.14.4 (**1.15.4**)*	*Reference* 1.14.1 *now reads* 1.15.1
2.2.1(a)	*Reference* 15.2.5 *now reads* 15.3.5
2.3.2	*Reference* 8.1.1 *now reads* 8.11.1
3.4.1	*Reference* 8.5 *now reads* 8.14
*5.3.4 (**5.3.5**)*	*Reference* 5.3.5 *now reads* 5.3.6
	Reference 5.3.6 *now reads* 5.3.7
*5.3.5 (**5.3.6**)*	*Reference* 5.3.4 *now reads* 5.3.5
*5.3.6 (**5.3.7**)*	*Reference* 5.3.4 *now reads* 5.3.5
*5.3.9 (**5.3.10**)*	*Reference* 5.3.8 *now reads* 5.3.9
6.9.3	*Reference* 15.2 *now reads* 15.3
16.1.2	*Reference* 1.14 *now reads* 1.15
	Reference 5.3.4 *now reads* 5.3.5
16.7.1	*Reference* 1.14 *now reads* 1.15
16.9.1	*Reference* 1.14 *now reads* 1.15
17.2.1	*Reference* 1.14 *now reads* 1.15
17.3.1	*Reference* 1.14 *now reads* 1.15
17.4.2	*Reference* 1.14 *now reads* 1.15

Part 7, Chapter 9

5.2.5	*Reference* 2.12 *now reads* 2.13 *Reference* 2.13 *now reads* 2.14

Part 7, Chapter 12

3.1.5	*Reference* 2.13.5 *now reads* 2.14.5

Part 7, Chapter 14

3.3.5	*Reference* 5.3.4 *now reads* 5.3.5
3.3.7	*Reference* 5.3.4 *now reads* 5.3.5
Table 14.3.1	*Reference* 5.3.4 *now reads* 5.3.5
Table 14.5.1	*Reference* 5.3.4 *now reads* 5.3.5
6.1.2	*Reference* Pt 6, Ch 2,1.3.5 *now reads* 5.3.5 *Reference* 1.3.6 *now reads* 1.3.5

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